YAMAHA
YAMAHA MOTOR CO., LTD.

SCARA ROBOTS

YK120X, YK180X

SERIES

OWNER'S MANUAL

Before using the robot
(Be sure to read the following notes.)

At this time, our thanks for your purchase of this YAMAHA YK-X series SCARA robot.

(1) Please be sure to perform the following tasks before using the robot.
Note that the robot may operate abnormally (abnormal vibration or noise) if the following work is not carried out.

Before the YK-X Series is shipped, the position shown in "Chapter 7, 1-2 External view and dimensions" is adjusted as the origin position, and the standard coordinates are provisionally set.

1. Absolute Reset

Absolute reset must be carried out just once before the YK-X Series robot can be used.
Once absolute reset is completed, it does not need to be carried out again when the power is turned ON the next time.
Refer to "Chapter 4, 3. Adjusting the origin" in this manual and "Absolute Reset" in the "YAMAHA Robot Controller owner's manual" for details on absolute reset.

2. Setting the standard coordinates

Set the standard coordinates while referring to instructions in "5. Setting the Standard coordinates" in Chapter 4 of this manual and also to "Setting the Standard coordinates" in the "YAMAHA robot controller owner's manual".
Robot malfunctions (vibration, noise) may occur if the standard coordinates are not set correctly.

Even though there is no problem with the robot, the following error messages are issued when the robot and controller are connected and power first turned on.
(Actual error messages may differ according to how the robot and controller are connected.)

Error messages issued when robot & controller are connected (RCX142)

17.27 : D?.ABS. backup failed (CPU)
17.80 : D?.ABS. backup failed (DRIVER)
17.81 : D?.ABS.battery wire breakage
17.92 : D?.Resolver disconnected during power off
17.93 : D?.Position backup counter overflow
17.94 : D?.ABS.battery low voltage
etc

(2) Caution when turning off the robot controller
On the YK120X and YK180X series robots, the harness exerts a large reaction force on the X and Y axis arms. When the power to the robot controller is turned off, the arm positions might move slightly due to the harness reaction force, depending on where the arms are positioned. If the arms moved a large distance in this case, the correct position data may not be backed up. To avoid this, before turning off the power to the robot controller, press the emergency stop button and check that the robot arms have completely stopped.

(3) Connection to the controller
The controller for the YK120X series robots (YK120X, YK150X) is designed to provide 24V output and the model name "RCX142-T" is shown on the serial number label (see Fig. 2-5). Do not connect other controllers to the YK120X series robot. If operated from a controller other than the RCX142-T, the robot's motors may be damaged.

Introduction

The YAMAHA YK120X and YK180 series robots are SCARA type industrial robots developed based on years of YAMAHA experience and achievements in the automation field as well as efforts to streamline our in-house manufacturing systems.
The SCARA robots have a two-joint manipulator consisting of an X-axis arm and a Y-axis arm, and are further equipped with a vertical axis (Z-axis) and a rotating axis (R-axis) at the tip of the manipulator. The YK120X and YK180 series robots can be used for a wide range of assembly applications such as installation and insertion of various parts, application of sealant, and packing operations.

This owner's manual describes the safety measures, handling, adjustment and maintenance of YK120X series robots for correct, safe and effective use. Be sure to read this manual carefully before installing the robot. Even after you have read this manual, keep it in a safe and convenient place for future reference.
This owner's manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.

This owner's manual explains the YAMAHA industrial robots YK120X series standard models (YK120X, YK150X), clean room models (YK120XC, YK150XC), and YK180X series (YK180X, YK220X).
Some descriptions of YK120XC and YK150XC are not listed in this manual when they are the same as standard models. Refer to the descriptions of standard models. For information on difference between the clean room model and standard model, refer to the description on the next page.
For details on specific operation and programming of the robot, refer to the separate "YAMAHA robot controller owner's manual".

NOTES

- The contents of this manual are subject to change without prior notice.
- Information furnished by YAMAHA in this manual is believed to be reliable. However, if you find any part unclear or inaccurate in this manual, please contact YAMAHA sales office or dealer.

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Clean Room Models YK120XC, YK150XC

Compared to standard YX120X and YK150X, clean room models differ in the following points.

1. Robot parameter has been changed. (See section 4 in chapter 2.)

The Z-axis speed is lowered to maintain the degree of cleanliness and the bellows durability. (This is preset prior to shipment.)

2. Suction couplers have been added. (See section 6 in chapter 3.)

For the suction amount versus degree of cleanliness, see "1-1 Basic specifications" in chapter 7. For the location of the suction couplers, see "1-2 External view and dimensions" in chapter 7.
The suction amount for each suction coupler is very important to maintain the degree of cleanliness and the bellows durability, so always comply with the instruction.

3. R-axis machine reference adjustment is different. (See section 3-4-1-2 in chapter 4.)

The structure around the R-axis origin sensor differs from standard specifications, so the method for adjusting the machine reference is different. Since the Z-axis bellows type suction tube is attached to the R-axis, care must be taken when performing return-to-origin so that the suction tube will not entangle around the R-axis.

4. Different grease is used for the Z-axis drive mechanism. (See section 4 in chapter 5.)

LG2 grease (NSK) suitable for clean room is used for the Z-axis ball screw, ball spline and linear bushing shaft.
Use the LG2 clean room grease for periodic maintenance.

5. Specifications and external appearance are somewhat changed. (See sections 1-1 and 1-2 in chapter 7.)

The X- and Y-axis repeated positioning accuracy and Z-axis maximum speed are different from standard specifications.
The external appearance and dimensions are different in that the Z-axis bellows, flexible tube and suction couplers are added.

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CHAPTER 4 Adjustment

MEMO

CHAPTER 1

Using the Robot Safely

MEMO

1 Safety Information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks. To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning information in this manual is shown classified into the following items.

⚠ DANGER

Failure to follow DANGER instructions will result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

⚠ WARNING

Failure to follow WARNING instructions could result in severe injury or death to the robot operator, a bystander or a person inspecting or repairing the robot.

⚠ CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, a bystander or a person inspecting or repairing the robot, or damage to the robot and/or robot controller.

Refer to the owner's manual by any of the following methods to operate or adjust the robot safely and correctly.

1. Operate or adjust the robot while referring to the printed version of the owner's manual (available for an additional fee).
2. Operate or adjust the robot while viewing the CD-ROM version of the owner's manual on your computer screen.
3. Operate or adjust the robot while referring to a printout of the necessary pages from the CD-ROM version of the owner's manual.

It is not possible to detail all safety items within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation. This manual and warning labels supplied with or affixed to the robot are written in English. If the robot operator or service personnel does not understand English, do not permit him to handle the robot.

2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

(1) Observe the following cautions during automatic operation.

Warning labels 1 (Fig. 1-1) are affixed to the robot. Refer to Fig. 2-2 to Fig. 2-4 in Chapter 2 for the position.

- Install a safeguard enclosure (protective enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.
- The warning labels shown in Fig. 1-1 are supplied with the robot and should be affixed to a conspicuous spot on doors or panels equipped with safety interlocks.

⚠ DANGER

Serious injury or death will result from impact with moving robot.
• Keep outside of guard during operation.
• Lock out power before approaching robot.

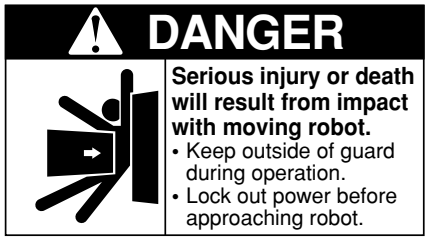
(2) Use caution to prevent hands or fingers from being pinched or crushed.

Warning labels 2 (Fig. 1-2) are affixed to the robot. Refer to Fig. 2-2 in Chapter 2 for the position.

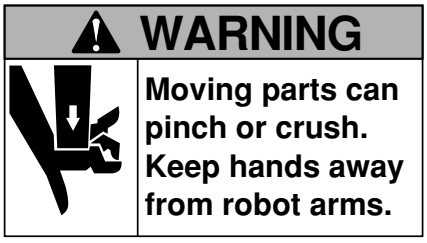
Be careful not to let hands or fingers be pinched or crushed by the moving parts of the robot during transportation or teaching.

⚠ WARNING

Moving parts can pinch or crush.
Keep hands away from robot arms.



■Fig. 1-1 Warning label 1



■Fig. 1-2 Warning label 2

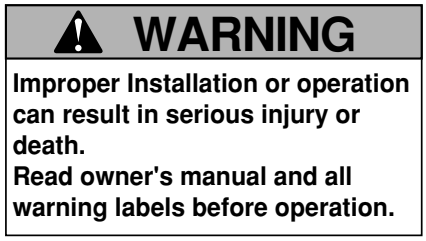
(3) Follow the instructions on warning labels and in this manual.

Warning label 3 (Fig. 1-3) is affixed to the robot. Refer to Fig. 2-2 to Fig. 2-4 in Chapter 2 for the position.

- Be sure to read the warning label and this manual carefully and make your thoroughly understand the contents before attempting installation and operation of the robot.
- Before starting the robot operation, even after you have read through this manual, read again the corresponding procedures and cautions in this manual as well as descriptions in the this chapter (Chapter 1, "Using the Robot Safely").
- Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.

⚠WARNING

Improper installation or operation can result in serious injury or death.
Read owner's manual and all warning labels before operation.



■Fig. 1-3 Warning label 3

(4) Do not use the robot in environments containing inflammable gas, etc.

⚠WARNING

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

(5) Do not use the robot in locations possibly subject to electromagnetic interference, etc.

⚠WARNING

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.

(6) Use caution when releasing the Z-axis (vertical axis) brake.

⚠WARNING

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation.

- Press the emergency stop button and prop up the Z-axis with a support stand before releasing the brake.
- Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.

(7) Provide safety measures for end effector (gripper, etc.).

⚠WARNING

- End effectors must be designed and manufactured so that they cause no hazards (for example, loosening of workpiece) even if power (electricity, air pressure, etc.) is shut off or power fluctuations occur.
- If there is a possible danger that the object gripped by the end effector may fly off or drop, then provide appropriate safety protection taking into account the object size, weight, temperature and chemical properties.

(8) Be cautious of possible Z-axis movement when the controller is turned off or emergency stop is triggered. (2-axis robots with air-driven Z-axis)

⚠WARNING

The Z-axis moves up when the power to the controller or PLC is turned off, the program is reset, emergency stop is triggered, or air is supplied to the solenoid valve for the Z-axis air cylinder.

- Do not let hands or fingers get caught and squeezed by moving parts of the Z-axis.
- Keep the usual robot position in mind so that the Z-axis will not interfere with obstacles during raising of the Z-axis, except in case of emergency stop.

(9) Use the following caution items when the Z-axis is interfering with peripheral equipment. (2-axis robots with air driven Z-axis)

⚠WARNING

When the Z-axis comes to a stop due to obstructions from peripheral equipment, the Z-axis may move suddenly when the obstruction is removed, causing injury such as pinched or crushed hands.

- Turn off the controller and reduce the air pressure before attempting to remove the obstruction.
- Before reducing the air pressure, place a support stand under the Z-axis because it will drop under its own weight.

(10) Use caution on Z-axis movement when air supply is stopped. (2-axis robots with air-driven Z-axis)

⚠ WARNING

The Z-axis may suddenly drop when the air pressure to the Z-axis air cylinder solenoid valve is reduced, creating a hazardous situation.
Turn off the controller and place a prop or support under the Z-axis before cutting off the air supply.

(11) Use the following caution items when disassembling or replacing the pneumatic equipment.

⚠ WARNING

Air or parts may fly outwards if pneumatic equipment is disassembled or parts replaced while air is still supplied.

- Do service work after first turning off the controller and reducing the air pressure.
- Before reducing the air pressure, place a support stand under the Z-axis (2-axis robots with air driven Z-axis) since it will drop under its own weight.

(12) Cautions for removing Z-axis brake or Z-axis motor

⚠ WARNING

The Z-axis can drop and cause a hazard when the Z-axis brake or Z-axis motor is removed.

- Turn off the controller and set a support stand under the Z-axis before removing the motor.
- Use caution not to allow hands or body to be squeezed or crushed by moving parts on the Z-axis or between the Z-axis and the installation base.

(13) Use the following caution during inspection of controller.

⚠ WARNING

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
- Never touch any internal parts of the controller.

For precautions on handling the controller, refer to the "YAMAHA robot controller owner's manual".

(14) Consult us for corrective action when the robot is damaged or malfunction occurs.

⚠WARNING

If any part of the robot is damaged or any malfunction occurs, continuous operation may be very dangerous. Please consult YAMAHA dealer for corrective action.

Damage or Trouble	Possible Danger
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot
Z-axis brake trouble	Dropping of load

(15) Use caution not to touch the controller rear panel cooling fan.

⚠WARNING

- Bodily injury may occur from coming into contact with the cooling fan while it is rotating.
- When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.

(16) Use caution not to touch the high temperature motor or speed reduction gear casing.

⚠WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched.
Before touching these parts during inspections or servicing, turn off the controller, wait for a while and check that the temperature has cooled.

(17) Do not remove, alter or stain the warning labels.

⚠WARNING

If warning labels are removed or difficult to see, necessary cautions may not be taken, resulting in an accident.

- Do not remove, alter or stain the warning labels on the robot.
- Do not allow the warning labels to be hidden by the device installed to the robot by the user.
- Provide proper lighting so that the symbols and instructions on the warning labels can be clearly seen even from the outside of safeguards.

(18) Protective bonding

⚠ WARNING

Be sure to ground the robot and controller to prevent electrical shock.

(19) Always connect the robot to the specified controller.

⚠ WARNING

The controller for the YK120X series robots (YK120X, YK150X) is designed to provide 24V output and the model name "RCX142-T" is shown on the serial number label (see Fig. 2-5). Do not connect other controllers to the YK120X series robot. If operated from a controller other than the RCX142-T, the robot's motors may be damaged.

(20) Avoid fastening any cable or tube prepared by the user with the machine harness, user signal wires or air tubes of the robot.

⚠ WARNING

Do not utilize the machine harness, user signal wires or air tubes of the robot to fasten any cable or tube prepared by the user, as this may break the robot harness wires or user signal wires causing malfunction of the robot. This will also result in poor positioning accuracy.

(21) Do not use the robot in locations subject to strong vibrations.

⚠ WARNING

Do not operate the robot in locations subject to strong vibrations. The robot installation bolts might work loose and the robot topple over. The bolts on the robot body itself might also loosen, causing parts to fall off, etc.

(22) Be sure to make correct parameter settings.

⚠ CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

(23) Do not use the robot for tasks requiring motor thrust.

⚠ CAUTION

Avoid using the YK-X series robots for tasks which make use of motor thrust (press-fitting, burr removal, etc.). These tasks may cause malfunctions of the robot.

(24) Do not apply excessive force to each section.

⚠CAUTION

The YK120X series (YK120X, YK150X) and YK180X series (YK180X, YK220X) are designed to be compact, so the joints could be damaged if excessive force is applied, for example, during installation of an end effector. Make sure that excessive force is not applied to the joints.

YK120X, YK150X

Axis	Tolerable radial load	Tolerable thrust load	Tolerable moment load	Tolerable torque
X-axis	100N (10.2kgf)	100N (10.2kgf)	1.5Nm (15.3kgfcm)	1.7Nm (17.3kgfcm)
Y-axis	45N (4.6kgf)	45N (4.6kgf)	0.45Nm (4.6kgfcm)	0.5Nm (5.1kgfcm)
R-axis	45N (4.6kgf)	45N (4.6kgf)	0.45Nm (4.6kgfcm)	0.3Nm (3.1kgfcm)

YK180X, YK220X

Axis	Tolerable radial load	Tolerable thrust load	Tolerable moment load	Tolerable torque
X-axis	275N (28.1kgf)	900N (91.8kgf)	6.0Nm (61.2kgfcm)	9.0Nm (91.8kgfcm)
Y-axis	150N (15.3kgf)	600N (61.2kgf)	3.3Nm (33.7kgfcm)	4.0Nm (40.8kgfcm)
R-axis	150N (15.3kgf)	600N (61.2kgf)	3.3Nm (33.7kgfcm)	2.2Nm (22.4kgfcm)

(25) Check the machine reference value when the arm struck against the mechanical stopper.

⚠CAUTION

When the arm moves at high speed and strikes against a mechanical stopper violently, the machine reference value may change. If this has happened, check the machine reference value. Also check the mechanical stopper for any damage and the origin position for shift. If the machine reference value is outside the recommended range, adjust the machine reference. In this case, re-teaching may be required if the origin position has shifted.

(26) Use caution not to apply excessive force to the machine harness, user signal cables and air tubes.

⚠CAUTION

A positioning error may occur if excessive force is applied to the machine harness, user signal cables or air tubes. A positioning error may also occur if the machine harness, user signal cables or air tubes have deteriorated due to improper installation environment.

(27) Caution when turning off the robot controller

⚠CAUTION

The XY arm positions might move slightly due to the harness reaction force when the power to the robot controller is turned off, making it difficult to back up the correct position data. To avoid this, before turning off the power to the robot controller, press the emergency stop button and check that the robot arms have completely stopped.

(28) Take the following precautions when transporting the robot.

⚠CAUTION

If the robot is transported long distances by truck while mounted on an installation base or packed in a case other than the dedicated carton box in which the robot was shipped, the bolts installing the robot or the bolts on the robot body itself might come loose due to vibration. The robot might then topple over or the parts fall off.
When transporting the robot long distances, use the dedicated case in which the robot was shipped from our factory.

3 Special Training for Industrial Robot Operation

Companies or factories using industrial robots must make sure that every person, who operates or handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely.

Since the YK120X and YK180X series robots fall under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

4 Robot Safety Functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power. If an overload error occurs, take the following measures.
1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(2) Overheat detection

This function detects an abnormal temperature rise in the driver inside the controller and shuts off the servo power. If an overheat error occurs, take the following measures.
1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.
Note: The working envelope is the area limited by soft limits.

(4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range.
On the X-axis, Y-axis arm, mechanical stoppers are fixed at both ends of the maximum movement range.
The Z-axis has a mechanical stopper at the upper end and lower end.
No mechanical stopper is provided on the R-axis.
Note: The movement range is the area limited by mechanical stoppers.

⚠WARNING

Axis movement will not stop immediately after the servo power supply is shut off by emergency stop or other safety functions.

(5) Z-axis (vertical axis) brake

An electromagnetic brake is installed on the Z-axis to prevent the Z-axis from sliding down when servo power is turned off. This brake is working when the controller is off or the Z-axis servo power is off even when the controller is on. The Z-axis brake can be released by means of the programming unit or by a command in the program when the controller is on.

⚠WARNING

The Z-axis will slide down when the Z-axis brake is released, creating a hazardous situation.
- Press the emergency stop button and prop the Z-axis with a support stand before releasing the brake.
- Use caution not to let your body get caught between the Z-axis and installation base when releasing the brake to perform direct teach.

5 Safety Measures for the System

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper owner's manual for safe, correct operation and servicing of the system.

6 Trial Operation

After making installations, adjustments, inspections, maintenance or repairs to the robot, make a trial run using the following procedures.

(1) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safeguard enclosure, and observe the following points.
   1. Use sturdy, stable posts which will not fall over easily.
   2. The rope or chain should be easily visible by everyone around the robot.
   3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.

(2) Check the following points before turning on the controller.
   1. Is the robot securely and correctly installed?
   2. Are the electrical connections to the robot correct?
   3. Are items such as air pressure correctly supplied?
   4. Is the robot correctly connected to peripheral equipment?
   5. Have safety measures (safeguard enclosure, etc.) been taken?
   6. Does the installation environment meet the specified standards.

(3) After the controller is turned on, check the following points from outside the safeguard enclosure.
   1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
   2. Does each axis move as intended within the soft limits?
   3. Does the end effector move as intended?
   4. Are the signal transmissions to the end effector and peripheral equipment correct?
   5. Does emergency stop work?
   6. Are the teaching and playback functions normal?
   7. Are the safeguard enclosure and interlock working as intended?
   8. Does the robot move correctly during automatic operation?

7 Work Within the Safeguard Enclosure

(1) When work is required inside the safeguard enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.

1) Adjusting the Z-axis machine reference (See Section 3-4-1-5 in Chapter 4.)
2) Setting the Soft Limits (See Section 4 in Chapter 4.)
3) Setting the Standard Coordinates (See Section 5 in Chapter 4.)
4) Teaching

For items 1) to 3), follow the precautions and procedure for each section. To perform item 4), refer to the description in (2) below.

(2) Teaching

When performing teaching within the safeguard enclosure, comply with the instructions listed below.

1) Check or perform the following points from outside the safeguard enclosure.
    1. Make sure that no hazards are present within the safeguard enclosure by a visual check.
    2. Check that the programming unit MPB operates correctly.
    3. Check that no failures are found in the robot.
    4. Check that emergency stop works correctly.
    5. Select teaching mode and prohibit automatic operation.
2) Never enter the movement range of the manipulator while within the safeguard enclosure.

8 Automatic Operation

Automatic operation described here includes all operations in AUTO mode.

(1) Check the following before starting automatic operation.
    1. No one is within the safeguard enclosure.
    2. The programming unit and tools are in their specified locations.
    3. The alarm or error lamps on the robot and peripheral equipment do not flash.
    4. The safeguard enclosure is securely installed with safety interlocks actuated.

(2) Observe the following during automatic operation or in cases where an error occurs.
    1) After automatic operation has started, check the operation status and warning lamp to ensure that the robot is in automatic operation.
    2) Never enter the safeguard enclosure during automatic operation.
    3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safeguard enclosure.
        1. Press the emergency stop button to set the robot to emergency stop.
        2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

9 Adjustment and Inspection

Do not attempt any installation, adjustment, inspection or maintenance unless it is described in this manual.

10 Repair and Modification

Do not attempt any repair, parts replacement and modification unless described in this manual. These works require technical knowledge and skill, and may also involve work hazards.

11 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:
(1) After 18 months (one and a half year) have elapsed from the date of shipment
(2) After one year has elapsed from the date of installation
(3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:
(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
2) Troubles caused by procedures prohibited in this manual.
3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
4) Use of any other than genuine parts and specified grease and lubricants.
5) Incorrect or inadequate maintenance and inspection.
6) Repairs by other than authorized dealers.

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12 CE Marking

When the YAMAHA robots are exported to or used in EU (European Union) countries, refer to the separate "YAMAHA robot controller owner's manual" or "CE marking manual" for related information about CE marking.

CHAPTER 2

Functions

MEMO

1 Robot Manipulator

The YK-X series robots are available in 4-axis models having an X/Y-axis arm (equivalent to human arm) and a Z/R-axis (equivalent to human wrist).
With these 4 axes, the YK-X series robots can move as shown in Fig. 2-1. By attaching different types of end effector (gripper) to the end of the arm, a wide range of tasks can be performed with high precision at high speeds.
The (+) and (-) signs show the direction of axis movement when the jog keys on the programming unit are pressed (standard setting at the factory). Fig. 2-2 to Fig. 2-4 on the subsequent pages show part names and functions of each robot model.

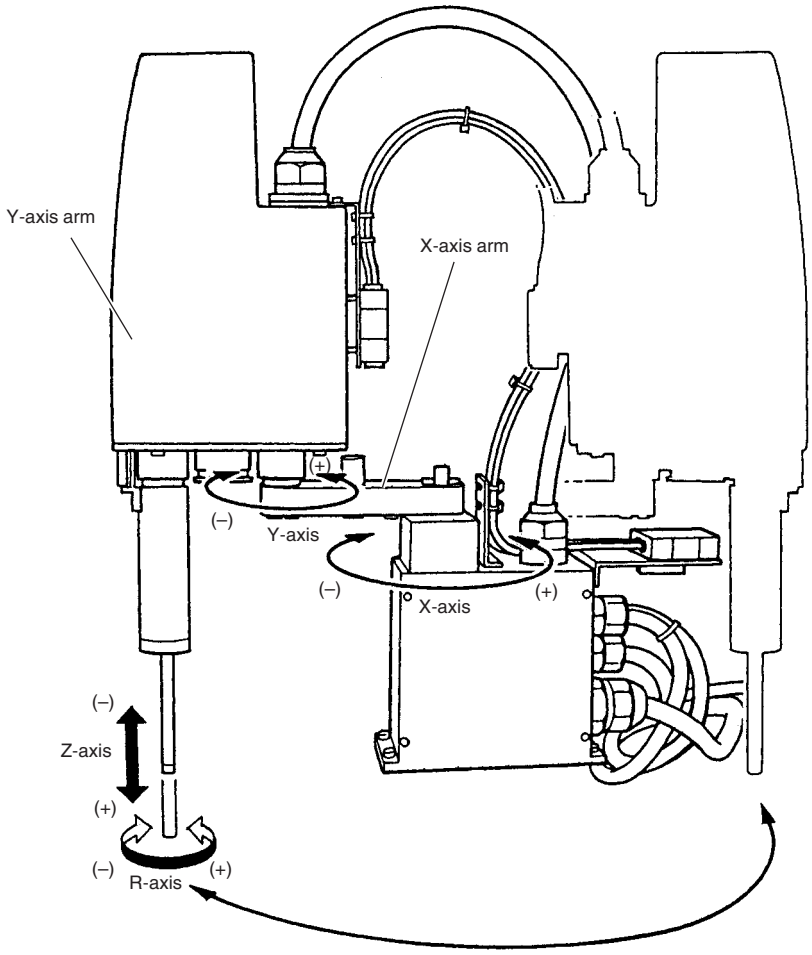


Fig. 2-1 Manipulator movement

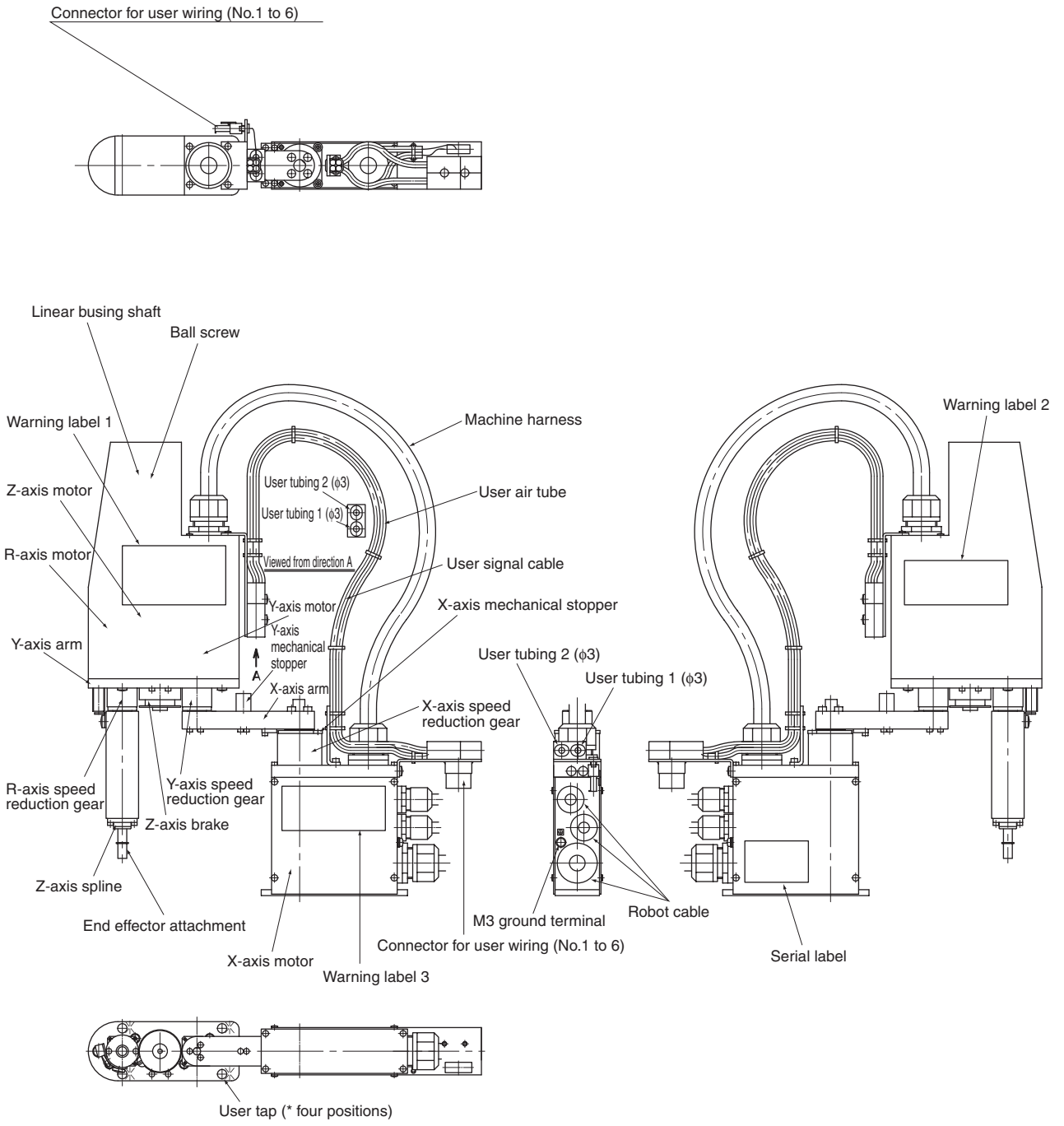


Fig. 2-2 YK120X, YK150X

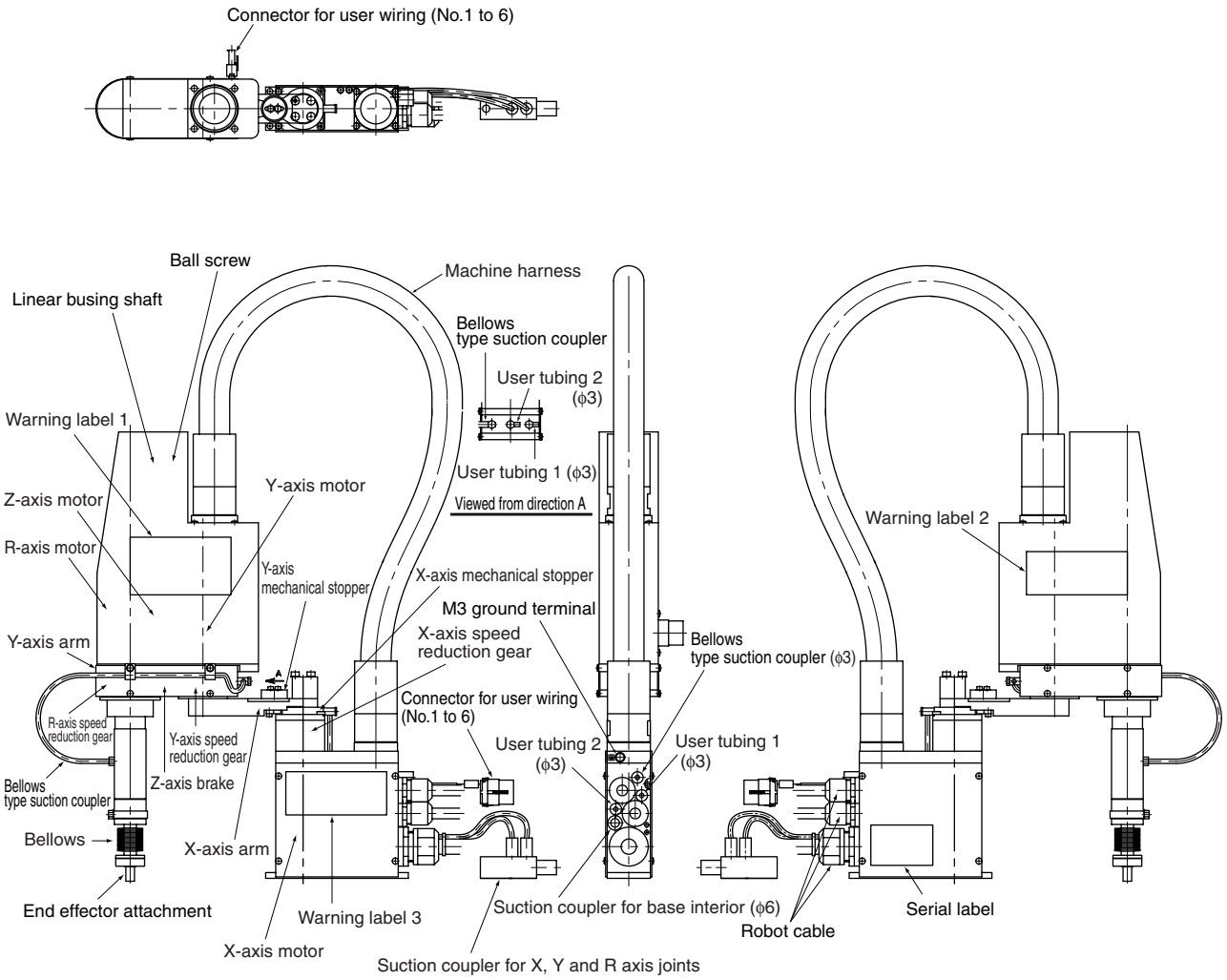


Fig. 2-3 YK120XC, YK150XC

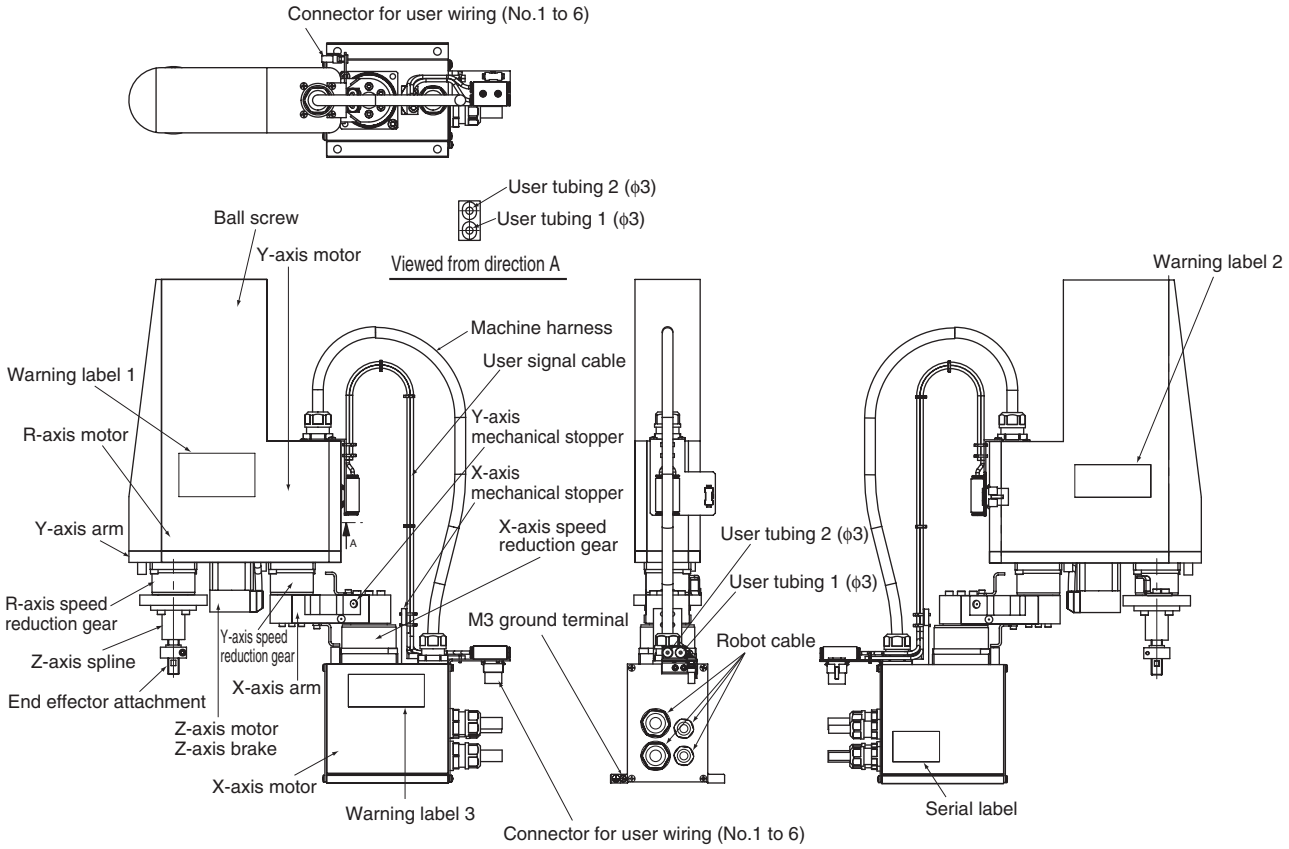


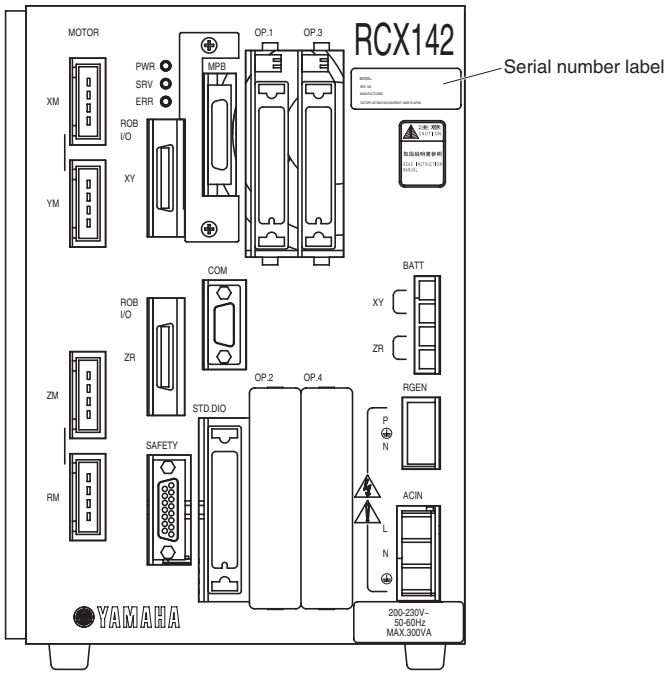
Fig. 2-4 YK180X, YK220X

2 Robot Controller

The YK120X series robots (YK120X, YK150X) come with a robot controller (RCX142-T).
The YK180X series robots (YK180X, YK220X) come with a robot controller (RCX142).
Refer to the separate "YAMAHA robot controller owner's manual" for details on the robot controller.

⚠ WARNING

For the YK120X series robots (YK120X, YK150X), always use the RCX142-T controller that is designed to provide 24V output. The model name "RCX142-T" is shown on the serial number label (see Fig. 2-5). Do not connect other robot controllers to the YK120X series robots. If operated from a controller other than the RCX142-T, the robot's motors may be damaged.



RCX142-T

Fig. 2-5 Robot controller for YK120X series (YK120X, YK150X)

3 Robot initialization number list

The YK-X series robots are initialized for optimum setting (default setting) according to the robot model prior to shipping. The robot controllers do not have to be reinitialized during normal operation. However, if for some reason the controller must be reinitialized, proceed while referring to the list below.

⚠CAUTION

Absolute reset must be performed after reinitializing the controller.
Before reinitializing the controller, read the descriptions in "3. Adjusting the origin" in Chapter 4 and make sure you thoroughly understand the procedure.

⚠CAUTION

When the controller is initialized, the "ARM LENGTH" and "OFFSET PULSE" settings in the axis parameters will be erased, making the standard coordinate settings invalid.
(Refer to "Chapter 4 Setting the Standard Coordinates" for details on the standard coordinates.)
Write down the "arm length" and "offset pulse" values before hand, and input each value again after completing the initialization process.

Robot initialization number

Robot initialization number	Robot model name	Applicable models
2020	YK120X	YK120X, YK120XC
2021	YK150X	YK150X, YK150XC
2115	YK180X	YK180X
2116	YK220X	YK220X

4 Parameters for Clean Room Models YK120XC, YK150XC

Part of robot parameters on clean room models has been changed to maintain the degree of cleanliness and the Z-axis bellows durability.
Along with this robot parameter change shown below, you must take the following precautions.

To purchasers of this robot

At this time our sincere thanks for your purchase of our robot.
Since this robot is custom designed and manufactured, a robot parameter has been changed from the standard specifications. Please keep this sheet carefully along with the owner's manual.
Check the following points before using the robot.

Precautions during use

Always make a backup of robot parameters.
Initializing the parameters deletes previous parameter settings. If necessary, load the backup parameters.

Parameter changes

The following parameter has been changed. Blank portions indicate standard specifications are used.

Axis settings

Parameter No.	Name	Changes			
		M1	M2	M3	M3
PRM37	Max. motor rotation			1500	

MEMO

CHAPTER 3

Installation

MEMO

1 Robot Installation Conditions

1-1 Installation environments

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	0 to 40°C
Allowable ambient humidity	35 to 85% RH (non condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust and liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge and radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Air supply pressure, etc.	Below 0.58MPa (6.0kgf/cm^2); clean dry air not containing deteriorated compressor oil; filtration 40μm or less
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For detailed information on how to install the robot controller, refer to the separate "YAMAHA robot controller owner's manual".

⚠ WARNING

Avoid installing the robot in locations where the ambient conditions may exceed the allowable temperature or humidity, or in environments where water, corrosive gases, metallic powder or dust are generated. Malfunction, failure or short circuits may otherwise result.

⚠ WARNING

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

⚠ WARNING

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunction may otherwise occur.

⚠ WARNING

Do not operate the robot in locations subject to strong vibrations. The robot installation bolts might work loose and the robot topple over. The bolts on the robot body itself might also loosen, causing parts to fall off, etc.

⚠ CAUTION

A positioning error may occur if the machine harness, user signal cables or air tubes have deteriorated due to improper installation environment.

1-2 Installation base

1) Prepare a sufficiently rigid and stable installation base, taking account of the robot weight including the end effector (gripper), workpiece and reaction force while the robot is operating. The maximum reaction force (see Fig. 3-1) applied to the X-axis and Z-axis of each robot during operation is shown in the table below. These values are an instantaneous force applied to the robot during operation and do not indicate the maximum load capacity.

The maximum reaction force

	Fxmax		Mxmax		Fzmax	
Robot Mode	N	kgf	Nm	kgfm	N	kgf
YK120X	23	2.3	3.3	0.34	6.7	0.7
YK150X	27	2.7	3.3	0.34	6.7	0.7
YK180X	196	20	18	1.8	6.7	0.7
YK220X	157	16	18	1.8	6.7	0.7

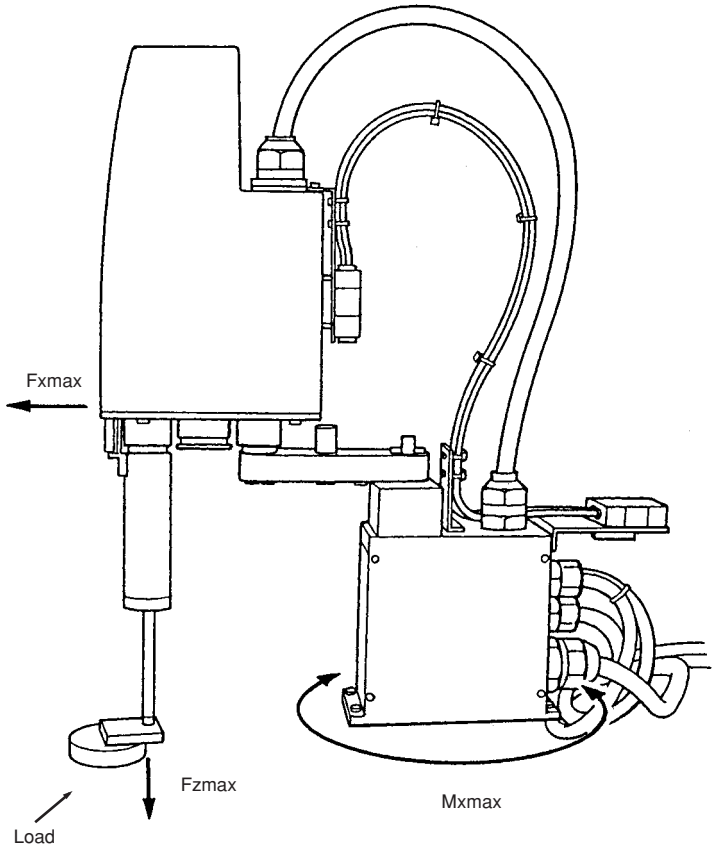


Fig. 3.1 Maximum reaction force applied during operation

2) The parallelism of the installation base surface must be machined within a precision of ±0.05mm/500mm. The robot base mount must be installed facing down and in a level position.
3) Tap holes into the surface of the installation base. Refer to "1-2 External view and dimensions" in Chapter 7 for machining dimensions and positions.
4) Securely fix the installation base on the floor with anchor bolts.

⚠ WARNING

Do not place the robot on a moving installation base. Excessive loads will be applied to the robot arm by movement of the installation base, resulting in damage to the robot.

⚠ CAUTION

The manipulator positioning might decrease if the installation surface precision is insufficient.

⚠ CAUTION

If the installation base is not sufficiently rigid and stable or a thin metallic plate is attached to the installation base, vibration (resonance) may occur during operation, causing detrimental effects on the manipulator work.

2 Installation

2-1 Unpacking

⚠WARNING

The robot and controller are heavy. Take sufficient care not to drop them during moving or unpacking as this may damage the equipment or cause bodily injury.

⚠CAUTION

When moving the robot or controller by equipment such as a folk-lift that require a license, only properly qualified personnel may operate it. The equipment and tools used for moving the robot should be serviced daily.

The package comes with a robot manipulator (YK120X series or YK180X series), a robot controller and accessories, according to the order specifications. Transport the package by dolly to near the installation base before unpacking. Take sufficient care not to apply shocks to the equipment when unpacking it.

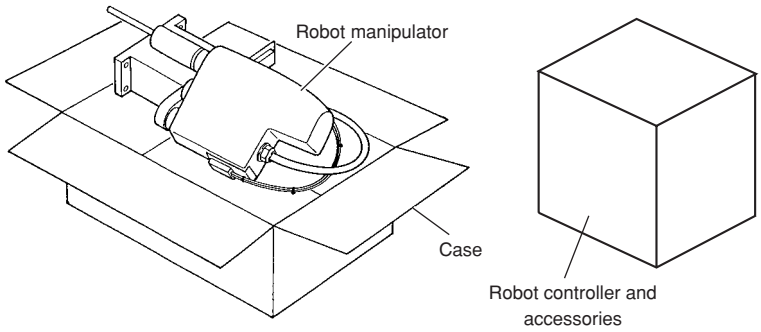


Fig. 3-2 Packed state

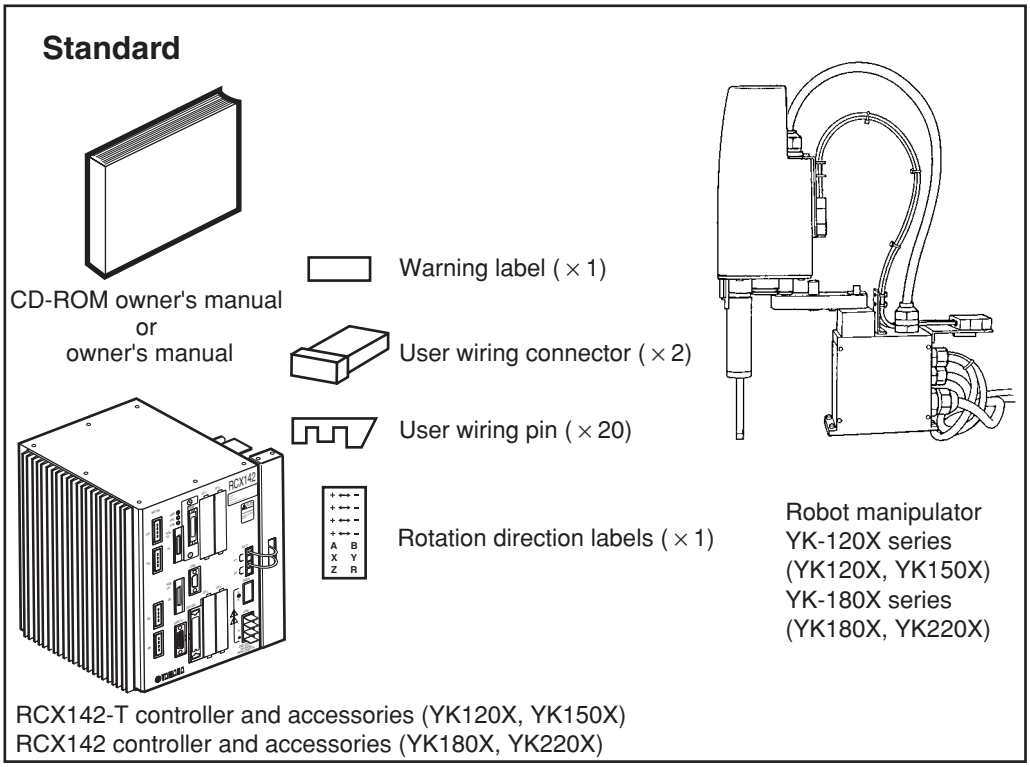
2-2 Checking the product

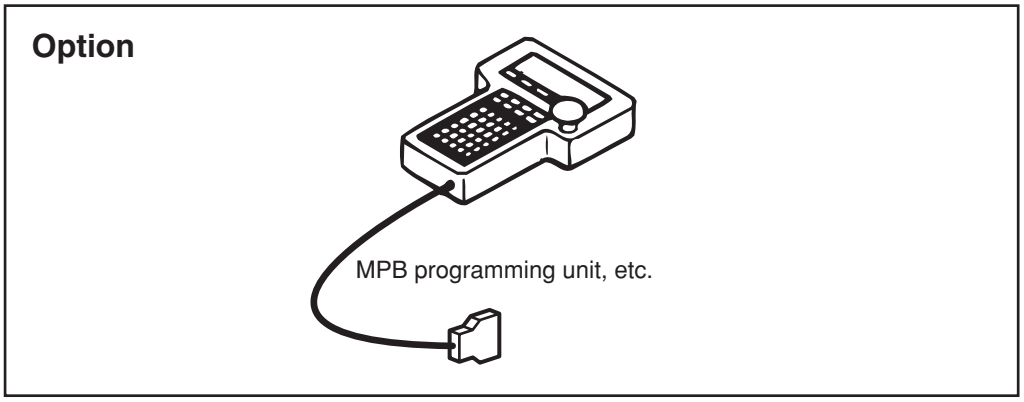
After unpacking, check the product configuration and conditions.
The following configurations are typical examples, so please check that the product is as specified in your order.

⚠CAUTION

If there is any damage due to transportation or insufficient parts, please notify your YAMAHA sales office or dealer immediately.

Controller : RCX142-T, RCX142
Robot : YK120X, YK150X, YK180X, YK220X





Refer to the "YAMAHA Robot Controller owner's manual" for details on the controller accessories and options.

Fig. 3-3 Product configurations

2-3 Moving the robot

1) Fold in the arm and wind the robot cable as shown in Fig. 3-4.

2) The robot must be carried by two workers. One worker must hold the support sections shown in the drawing with both hands, and the other worker must carry the robot cable. Place the robot on the installation base, and temporarily tighten with the bolts. (Refer to section "2-4 Installing the robot" for the bolt tightening torque values.)

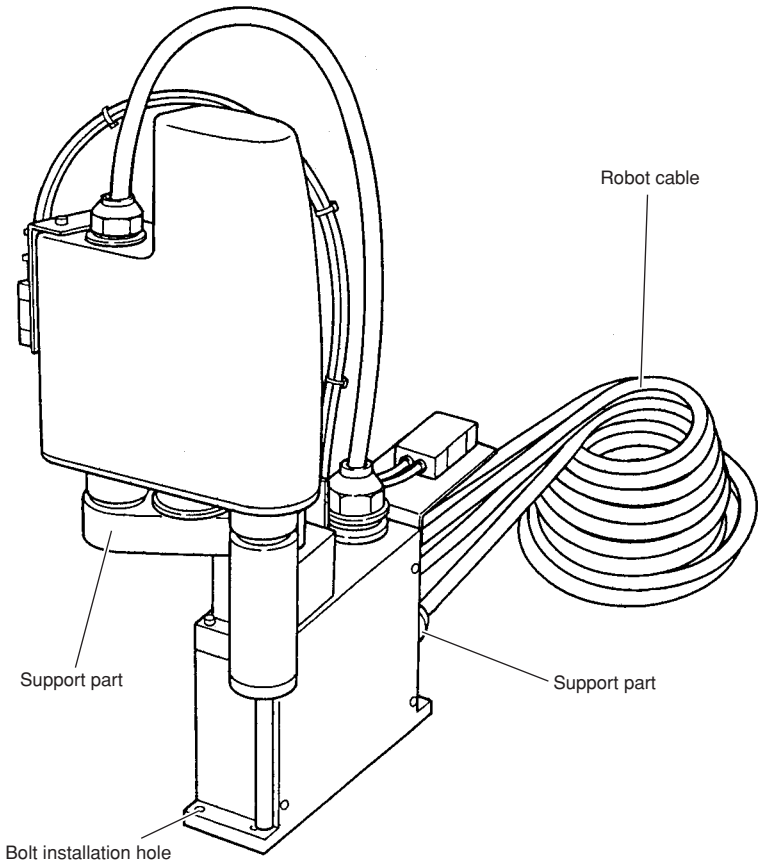


Fig. 3-4

⚠CAUTION

If the robot is transported long distances by truck while mounted on an installation base or packed in a case other than the dedicated carton box in which the robot was shipped, the bolts installing the robot or the bolts on the robot body itself might come loose due to vibration. The robot might then topple over or the parts fall off.
When transporting the robot long distances, use the dedicated case in which the robot was shipped from our factory.

2-4 Installing the robot

Install the robot securely with the four hex socket head bolts as shown in Fig. 3-5.

⚠ WARNING

Be sure to use the specified type and number of bolts, and securely tighten them to the correct torque. If the bolts are not tightened correctly, the robot may cause positioning errors or fall over during operation, causing a serious accident.

Tightening torque

Robot Mode	Bolts Used	Tightening torque
YK120X, YK150X	M3	2.0Nm (20kgfcm)
YK180X, YK220X	M6	15.3Nm (156kgfcm)

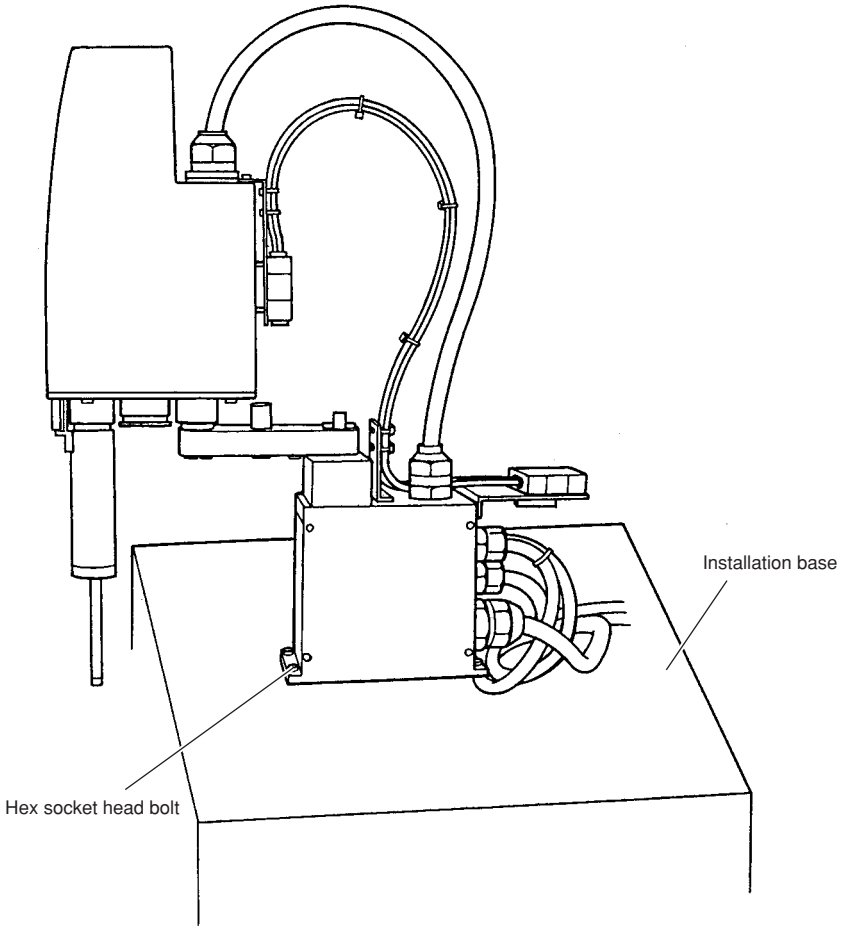


Fig. 3-5 Installing the robot

3 Protective Bonding

⚠ WARNING

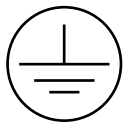
Be sure to ground the robot and controller to prevent electrical shock.

⚠ WARNING

Turn off the controller before grounding the robot.

The robot must be grounded as follows:

1) Provide a terminal marked "PE" for the protective conductor of the entire system and connect it to an external protective conductor. In addition, securely connect the ground terminal on the robot pedestal to the same protective conductor. (See Fig. 3-6.)

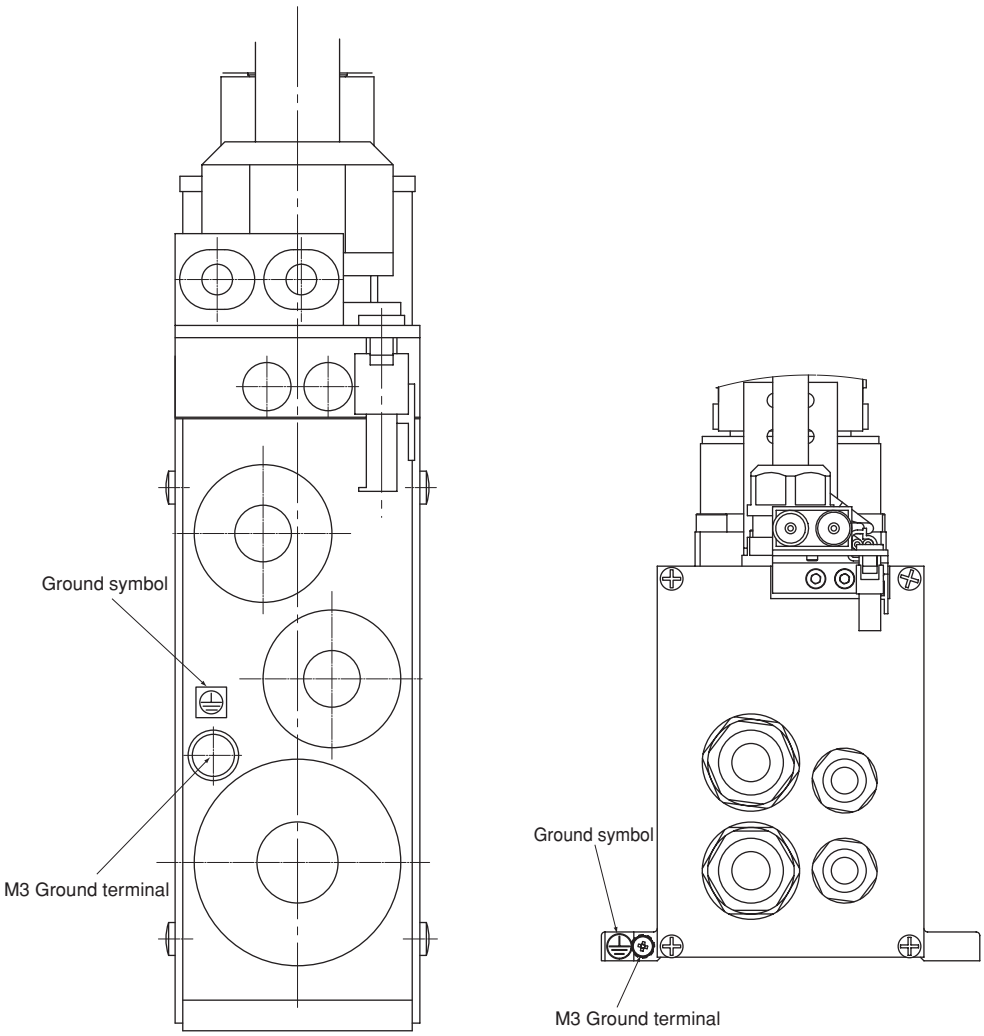


(Symbol 417-IEC-5019)

2) When the end effector uses an electrical device which, if it malfunctions, might make contact with the power supply, the user must provide proper grounding on his own responsibility. The YK-X series robots do not have a ground terminal for this purpose.

3) For details on protective bonding on the robot body to comply with CE marking, follow the instructions on protective bonding explained in the "YAMAHA robot controller owner's manual" or "CE marking manual".

4) Use a ground cable with a conductor wire cross section of at least 2.0mm^2 and a length within 1 meter.



YK120X, YK150X YK180X, YK220X

Fig. 3-6 Ground terminal

4 Robot Cable Connection

The robot cable is pre-connected to each robot. Correctly install the other end of the robot cable to the robot controller. For details on connections to the robot controller, refer to Fig. 3-7 and the "YAMAHA RCX142 robot controller owner's manual". After making connections, check the operation while referring to "6 Trial operation" in Chapter 1.

⚠ WARNING

- Before connecting the cables, check that there are no bends or breaks in the connector pins of the robot cable and that the cables are not damaged. Bent or broken pins or cable damage may cause malfunction of the robot.
- Ensure that the controller is off before connecting the robot cable to the controller.

⚠ WARNING

The MOTOR connectors XM and ZM, and YM and RM each have identical shapes. In addition, the PI connectors XY and ZR have identical shapes. Do not confuse these connectors when making connections. Wrong connections may result in malfunction and hazardous situations.

⚠ WARNING

- If the connector installation is inadequate or if there are contact failures in the pins, the robot may malfunction causing a hazardous situation. Reconfirm that each connector is securely installed before turning on the controller.
- To attach the PI connector securely, tighten the screws supplied with the robot.
- Take caution not to apply an excessive load to the connectors due to stress or tension on the cables.

⚠ WARNING

Lay out the cables so that they do not obstruct the movement of the manipulator. Determine the robot work area in which the robot cables will not interfere with the load or workpiece picked up by the manipulator. (See "1-2 External view and dimensions" in Chapter 7.) If the robot cables interfere with the movable parts of the robot, the cables may be damaged causing malfunction and hazardous situations.

⚠ WARNING

Lay out the robot cables so as to keep the operator or any other person from tripping on them. Bodily injury may result if someone trips on the cables.

⚠ WARNING

For the YK120X series robots (YK120X, YK150X), always use the RCX142-T controller that is designed to provide 24V output. The model name "RCX142-T" is shown on the serial number label (see Fig. 2-5). Do not connect other robot controllers to the YK120X series robots. If operated from a controller other than the RCX142-T, the robot's motors may be damaged.

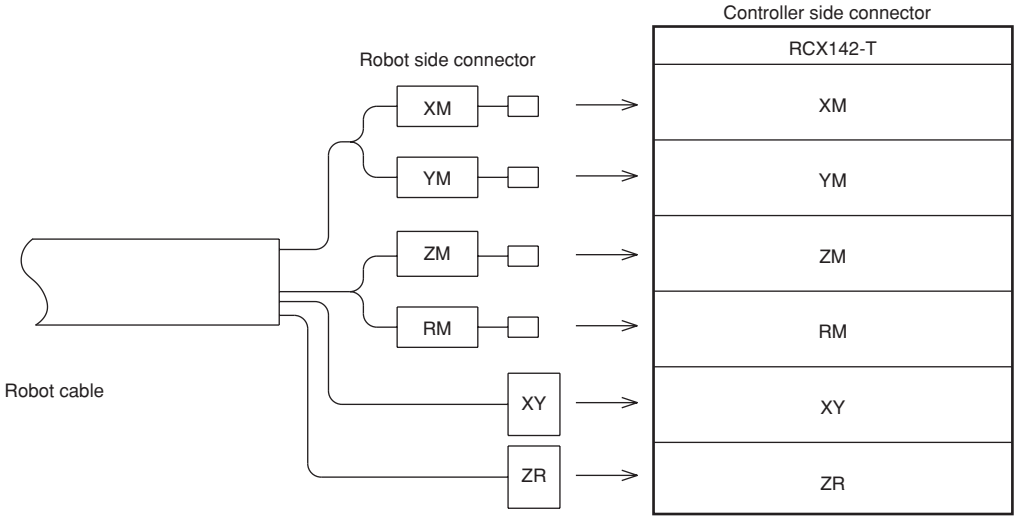


Fig. 3-7 Robot cable connections

5 User Wiring and User Tubing

⚠ WARNING

Always turn off the controller and shut off air supply before attempting wiring and piping work. If air or power is supplied during this work, the manipulator may move erroneously causing a hazardous situation.

1) The robot has a user signal wire and air tube laid in parallel with the robot body's machine harness. The signal wires and air tubes that can be used are shown below.

User wiring	User tubing
6 wires	ϕ3, 2 tubes

(Robot models for custom specifications may have different wiring or tubing.)
The specifications of the user wires and air tubes are shown below. Always observe the specifications.

User signal cable

Rated voltage	30V
Allowable current	1.5A
Nominal cross-section area of conductor	0.1mm^2
Shield	No

User Tubing

Maximum pressure	0.58MPa (6Kgf/cm^2)
Outer diameter × inner diameter	ϕ3×ϕ1.5
Fluid	Dry clean air not containing deteriorated compressor oil; filtration 40μm or less

2) User wiring connectors and user piping joints are provided on the arm side and base side. Refer to "Chapter 7, 1-2. External view and dimensions" for the positions.

3) Signal wiring connections in the machine harness

Connector pins 1 to 6 can be used.

Signal	Connector	No	Connection	No	Connector	Color
User signal line	I O (Arm side)	1		1	I O (Base side)	Orange
		2		2		Orange
		3		3		Orange
		4		4		Orange
		5		5		Orange
		6		6		Orange

(Robots models with non-standard specifications may have different wiring colors.)

4) Crimp the user wiring to the connector (supplied) using a crimping tool (J.S.T. Mfg Co., Ltd. YC12) or solder as shown in Fig. 3-8.

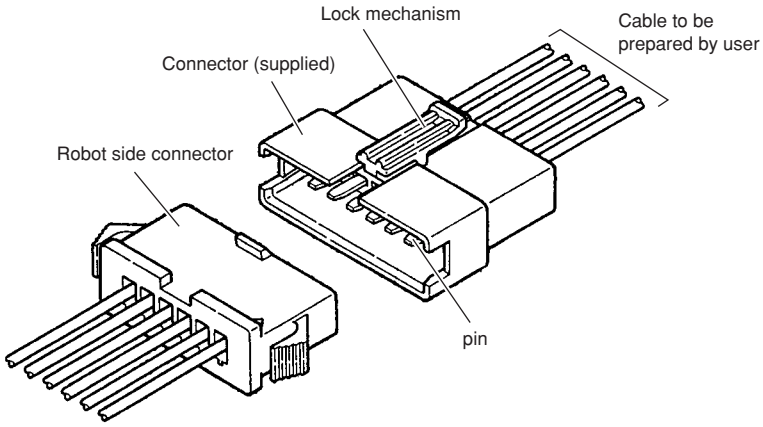


Fig. 3-8

⚠ WARNING

Securely fix the connector (supplied) to the robot's connector using the lock mechanism attached with the housing (See Fig. 3-8). The operation could malfunction if the connector dislocates.

⚠ WARNING

Do not utilize the machine harness, user signal wires or air tubes of the robot to fasten any cable or tube prepared by the user, as this may break the robot harness wires or user signal wires causing malfunction of the robot. This will also result in poor positioning accuracy.

⚠ WARNING

Make sure that user wiring and piping connected with the user wiring connector and user wiring joint do not interfere with the robot, get wound around the robot or led around when the robot moves. The wiring and piping could be damaged and result in malfunctioning.

⚠ WARNING

Arrange the user wiring and piping installed with the user wiring connector and user piping joint not to pose hazards for the operators. The operators could trip on these parts and be injured.

⚠ CAUTION

Always use the supplied connectors and pins. Contact faults could occur if other types are used.

Arm side and base side connector (supplied)	Pin	Manufacture
SM Connector SMR-6V-B	BYM-001T-0.6 or SYM-001T-P0.6	J.S.T. Mfg Co., Ltd.

5) To check the operation and signal transmission between the end effector and the controller or peripheral equipment after making connections, refer to "6. Trial operation" in Chapter 1.

6 Connecting a suction hose (YK120XC, YK150XC)

⚠WARNING

Always turn off the robot controller and shut off air supply before connecting a suction hose.

Clean room models have two suction couplers (ϕ6) on the rear of the manipulator base for air suction from the base interior and from the X, Y, R axis joints, and also have one bellows type suction coupler (ϕ3) for the R-axis.
The required degree of cleanliness can be maintained by sucking air through these suction couplers.
For the suction amount versus degree of cleanliness, see "1-1 Basic specifications" in chapter 7. For the location of the suction couplers, see "1-2 External view and dimensions" in chapter 7.

⚠WARNING

Lay out the suction hoses so as to keep the operator or any other person from tripping on them. Bodily injury may result if someone trips on the hoses.

⚠CAUTION

Carefully connect the suction hoses to the suction couplers so that they do not obstruct the movement of the robot manipulator.

7 Attaching The End Effector

7-1 R-axis tolerable moment of inertia and acceleration coefficient

1) The moment of inertia of a load (end effector and workpiece) that can be attached to the R-axis is limited by the strength of the robot drive unit and residual vibration during positioning. It is therefore necessary to reduce the acceleration coefficient in accordance with the moment of inertia.

2) The R-axis tolerable moment of inertia and the acceleration coefficient versus R-axis moment of inertia for each robot model are shown in Fig. 3-9, Fig. 3-10 and Fig. 3-11 on the subsequent pages. The symbols A_X, A_Y, and A_R in each figure respectively indicate the acceleration coefficients of the X-axis, Y-axis and R-axis. The symbol I_R (J_R) is the moment of inertia of the load around the R-axis and m is the tip mass.

   Example: YK120X
   Assume that the mass of the load installed to the R-axis is 0.15kg and the moment of inertia around the R-axis is 0.0005kgm^2 (0.005kgfcmsec^2). When the tip mass parameter is set to 0.2kg, the robot can be operated by reducing the X, Y and R-axis acceleration coefficients to 50%, as can be seen from Fig. 3-9.
   Be sure to select an optimum tip mass and acceleration coefficient parameters that meet the mass of the load and moment of inertia before using the robot.
   To make settings for the tip mass and acceleration coefficient, refer to the separate "YAMAHA robot controller owner's manual".

3) Methods for calculating the moment of inertia of the load are shown in Section 6-2, however, it is not easy to precisely figure out these values.
   If a calculated value smaller than the actual moment of inertia is set, residual vibrations may occur. If this happens, reduce the acceleration coefficient parameter even further.

⚠CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

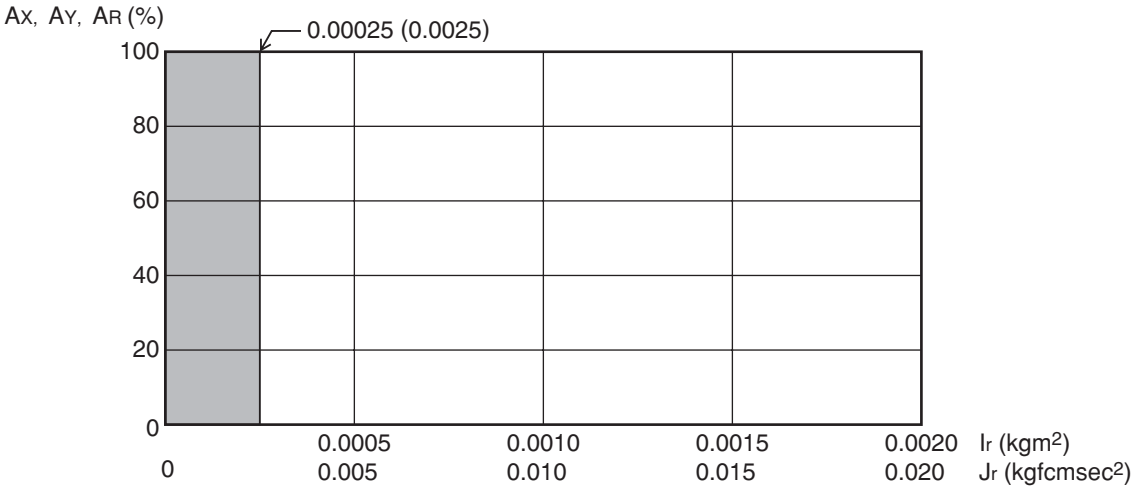
⚠CAUTION

Depending on the Z-axis position, vibration may occur when the X, Y or R-axis moves. If this happens, reduce the X, Y or R-axis acceleration to an appropriate level.

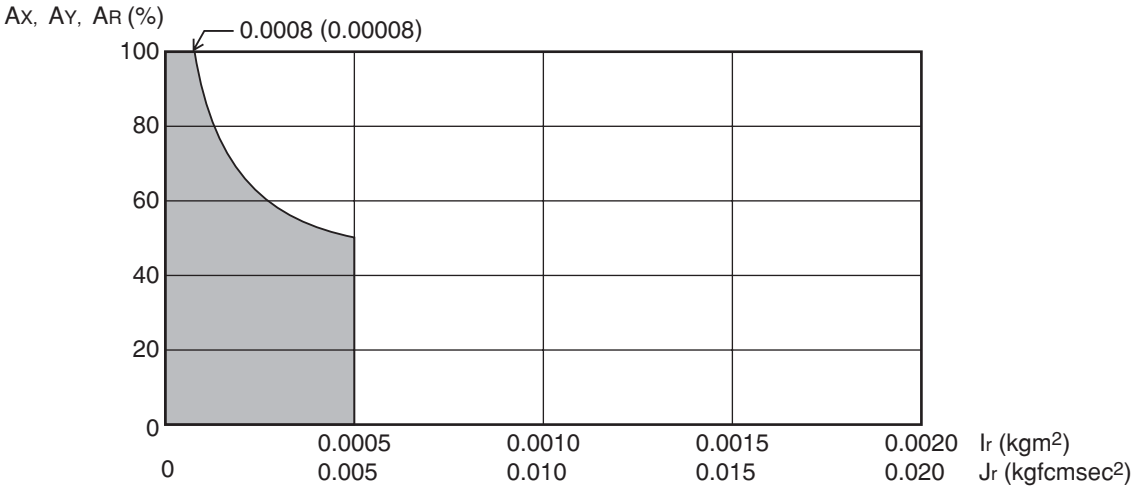
⚠CAUTION

If the moment of inertia is too large, vibration may occur on the Z-axis depending on its operation position. If this happens, reduce the Z-axis acceleration to an approriate level.

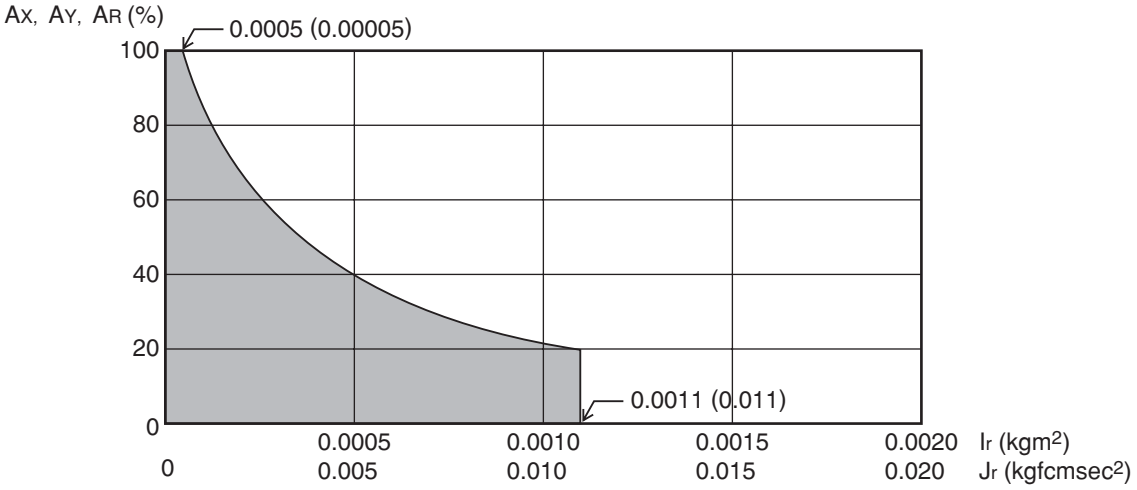
7-1-1 Acceleration coefficient vs. moment of inertia (YK120X)



W=0.1kg



W=0.2kg



W=0.3kg

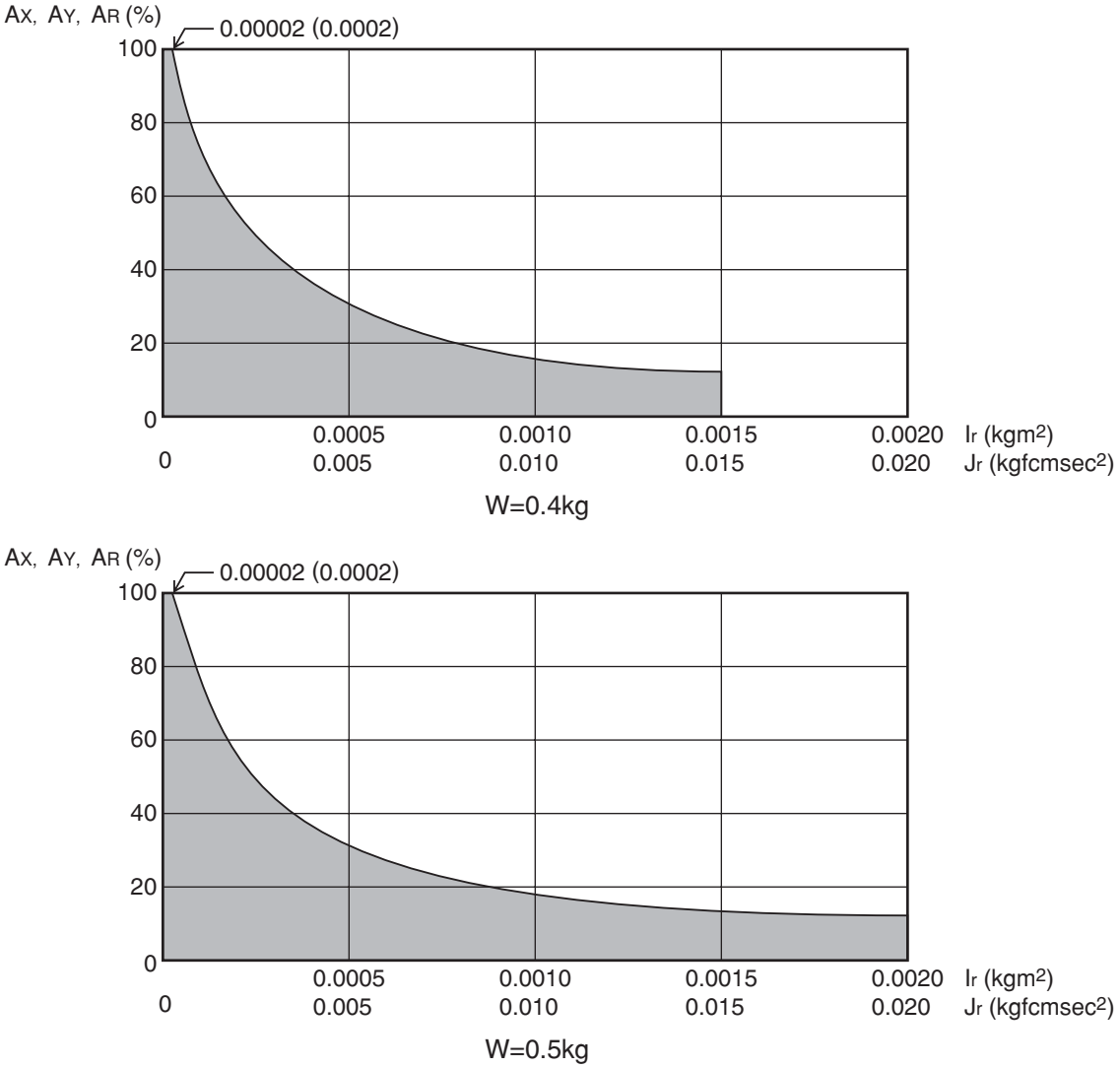
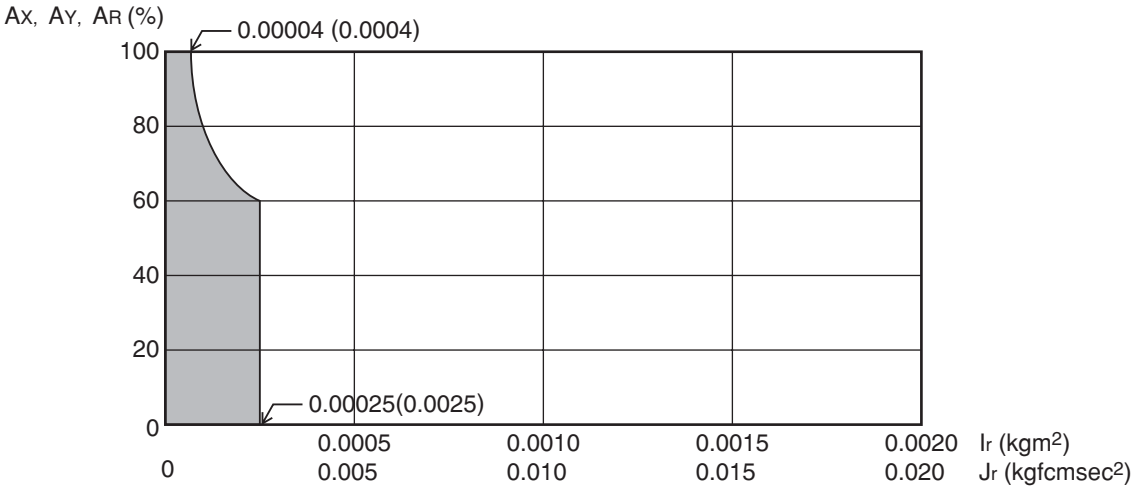
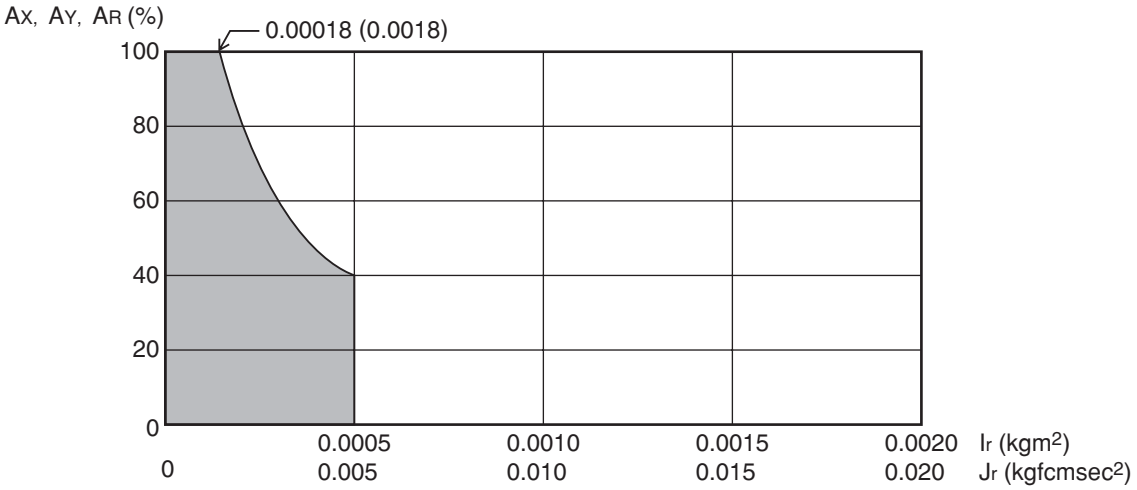

AX, AY, AR (%)
0.00002 (0.0002)
100
80
60
40
20
0
0.0005
0.0010
0.0015
0.0020
Ir (kgm2)
0
0.005
0.010
0.015
0.020
Jr (kgfcmsec2)
W=0.4kg
AX, AY, AR (%)
0.00002 (0.0002)
100
80
60
40
20
0
0.0005
0.0010
0.0015
0.0020
Ir (kgm2)
0
0.005
0.010
0.015
0.020
Jr (kgfcmsec2)
W=0.5kg

Fig. 3-9

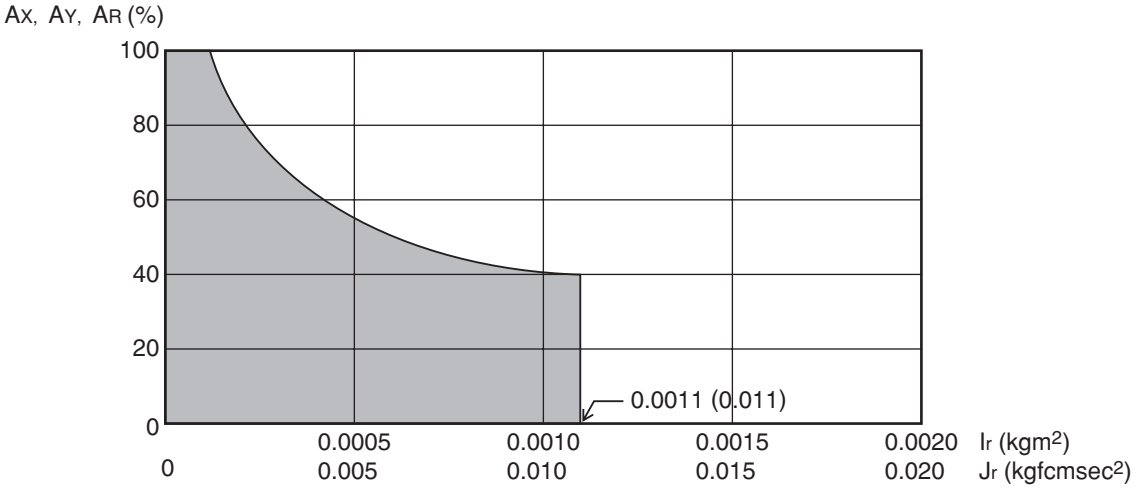
7-1-2 Acceleration coefficient vs. moment of inertia (YK150X)



W=0.1kg



W=0.2kg



W=0.3kg

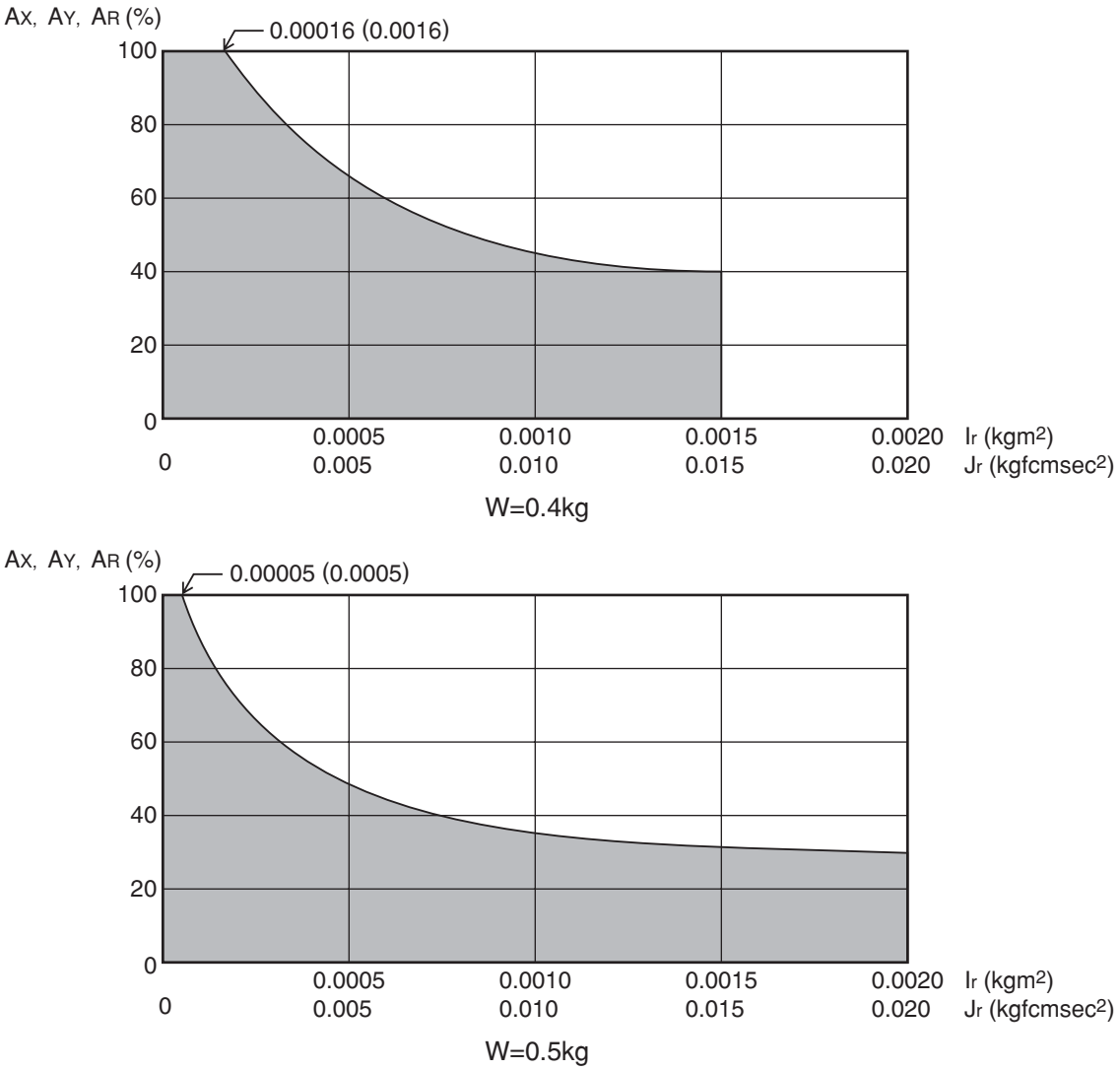
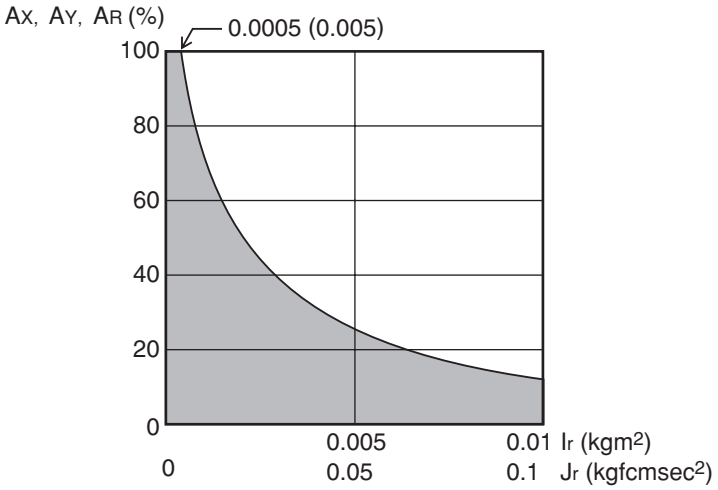
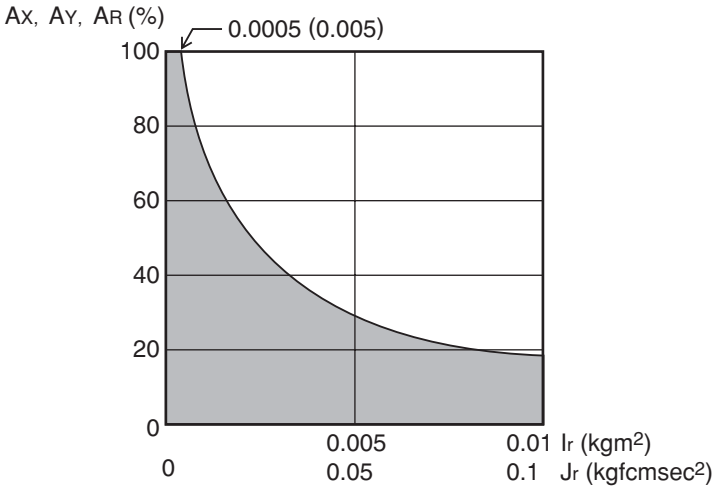

AX, AY, AR (%)
0.00016 (0.0016)
100
80
60
40
20
0
0.0005
0.0010
0.0015
0.0020
Ir (kgm2)
0
0.005
0.010
0.015
0.020
Jr (kgfcmsec2)
W=0.4kg
AX, AY, AR (%)
0.00005 (0.0005)
100
80
60
40
20
0
0.0005
0.0010
0.0015
0.0020
Ir (kgm2)
0
0.005
0.010
0.015
0.020
Jr (kgfcmsec2)
W=0.5kg

Fig. 3-10

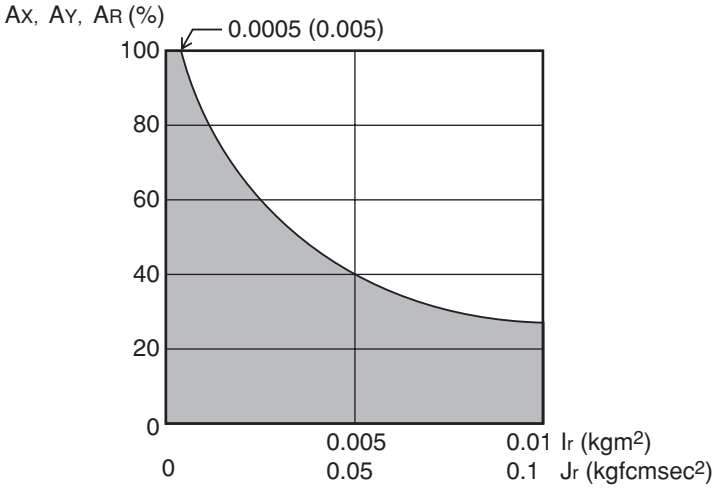
7-1-3 Acceleration coefficient vs. moment of inertia (YK180X, YK220X)



W=0.1 to 0.4kg



W=0.5 to 0.8kg



W=0.9, 1.0kg

Fig. 3-11

7-2 Equation for moment of inertia calculation

Usually the R axis load is not a simple form, and the calculation of the moment of inertia is not easy.
As a method, the load is replaced with several factors that resemble a simple form for which the moment of inertia can be calculated. The total of the moment of inertia for these factors is then obtained.
The objects and equations often used for the calculation of the moment of inertia are shown below. Incidentally, there is the following relation:
$J\ (kgfcmsec^2) = I\ (kgm^2) \times 10.2$.

1) Moment of inertia for material particle
The equation for the moment of inertia for a material particle that has a rotation center such as shown in Fig. 3-12 is as follows:
This is used as an approximate equation when x is larger than the object size.

$$I = mx^2\ (kgm^2)$$

$$J = \frac{Wx^2}{g}\ (kgfcmsec^2)$$

... (Eq. 3.1)

g : Gravitational acceleration (cm/sec^2)
m : Mass of material particle (kg)
W : Weight of material particle (kgf)

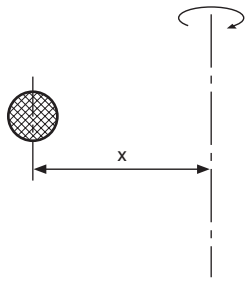


Fig. 3-12

2) Moment of inertia for cylinder (part 1)
The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-13 is given below.

$$I = \frac{\rho\pi D^4 h}{32} = \frac{mD^2}{8}\ (kgm^2)$$

$$J = \frac{\rho\pi D^4 h}{32g} = \frac{WD^2}{8g}\ (kgfcmsec^2)$$

... (Eq. 3.2)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

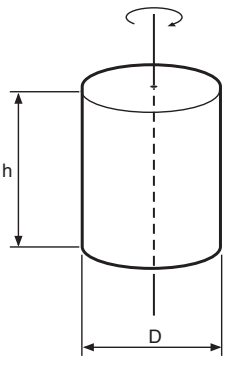


Fig. 3-13

3) Moment of inertia for cylinder (part 2)

The equation for the moment of inertia for a cylinder that has a rotation center such as shown in Fig. 3-14 is given below.

$$I = \frac{\rho\pi D^2 h}{16}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) = \frac{m}{4}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) \quad (kgm^2)$$

$$J = \frac{\rho\pi D^2 h}{16g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) = \frac{W}{4g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right) \quad (kgfcmsec^2)$$

... (Eq. 3.3)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

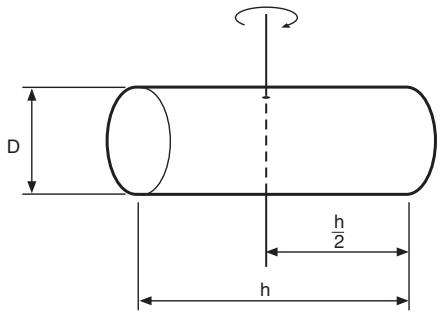


Fig. 3-14

4) Moment of inertia for prism

The equation for the moment of inertia for a prism that has a rotation center as shown in Fig. 3-15 is given as follows.

$$I = \frac{\rho\, abc(a^2+b^2)}{12} = \frac{m(a^2+b^2)}{12} \quad (kgm^2)$$

$$J = \frac{\rho\, abc(a^2+b^2)}{12g} = \frac{W(a^2+b^2)}{12g} \quad (kgfcmsec^2)$$

... (Eq. 3.4)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of prism (kg)
W : Weight of prism (kgf)

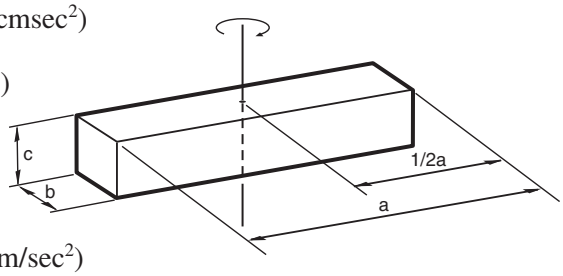


Fig. 3-15

5) When the object's center line is offset from the rotation center.
The equation for the moment of inertia, when the center of the cylinder is offset by the distance "x" from the rotation center as shown in Fig. 3-16, is given as follows.

$$I=\frac{\rho\pi D^4 h}{32}+\frac{\rho\pi D^2 h x^2}{4}=\frac{mD^2}{8}+mx^2 \quad (kgm^2)$$

$$J=\frac{\rho\pi D^4 h}{32g}+\frac{\rho\pi D^2 h x^2}{4g}$$

$$=\frac{WD^2}{8g}+\frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.5)

ρ : Density (kg/m^3, kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
m : Mass of cylinder (kg)
W : Weight of cylinder (kgf)

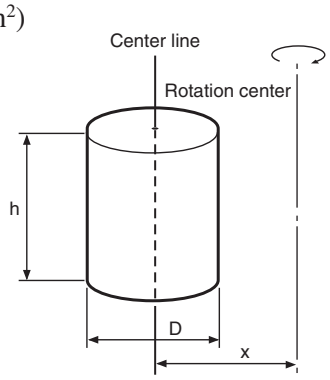


Fig. 3-16

In the same manner, the moment of inertia of a cylinder as shown in Fig. 3-17 is given by

$$I=\frac{\rho\pi D^2 h}{16}\left(\frac{D^2}{4}+\frac{h^2}{3}\right)+\frac{\rho\pi D^2 h x^2}{4}=\frac{m}{4}\left(\frac{D^2}{4}+\frac{h^2}{3}\right)+mx^2 \quad (kgm^2)$$

$$J=\frac{\rho\pi D^2 h}{16g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right)+\frac{\rho\pi D^2 h x^2}{4g}$$

$$=\frac{W}{4g}\left(\frac{D^2}{4}+\frac{h^2}{3}\right)+\frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.6)

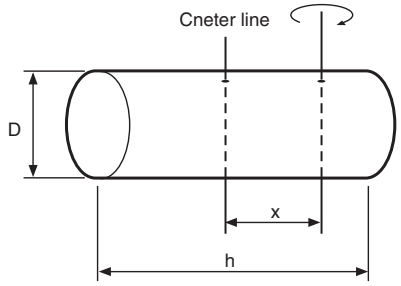


Fig. 3-17

In the same manner, the moment of inertia of a prism as shown in Fig. 3-18 is given by

$$I=\frac{\rho abc(a^2+b^2)}{12}+\rho abcx^2=\frac{m(a^2+b^2)}{12}+mx^2 \quad (kgm^2)$$

$$J=\frac{\rho abc(a^2+b^2)}{12g}+\frac{\rho abcx^2}{g}$$

$$=\frac{W(a^2+b^2)}{12g}+\frac{Wx^2}{g} \quad (kgfcmsec^2)$$

... (Eq. 3.7)

m : Mass of prism (kg)
W : Weight of prism (kgf)

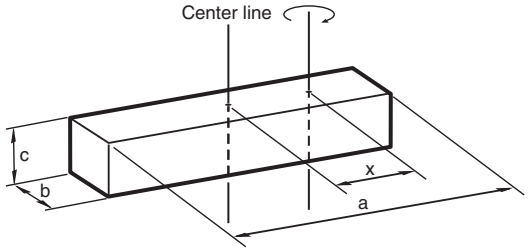


Fig. 3-18

7-3 Example of moment of inertia calculation

Let's discuss an example in which the chuck and workpiece are at a position offset by 10cm from the R-axis by a stay, as shown in Fig. 3-19.
The moment of inertia is calculated with the following three factors, assuming that the load material is steel and its density ρ is 0.0078kg/cm^3.

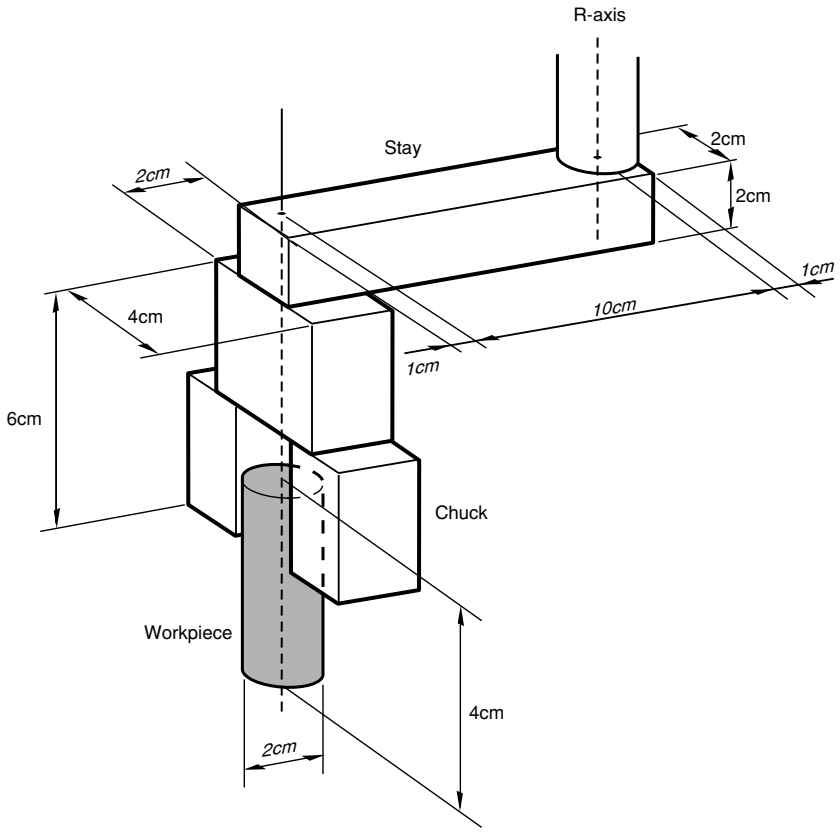


Fig. 3-19

1) Moment of inertia of the stay

From Fig. 3-20, the weight of the stay (Ws) is given as follows:

$$Ws = \rho abc = 0.0078 \times 12 \times 2 \times 2 = 0.37 \text{ (kgf)}$$

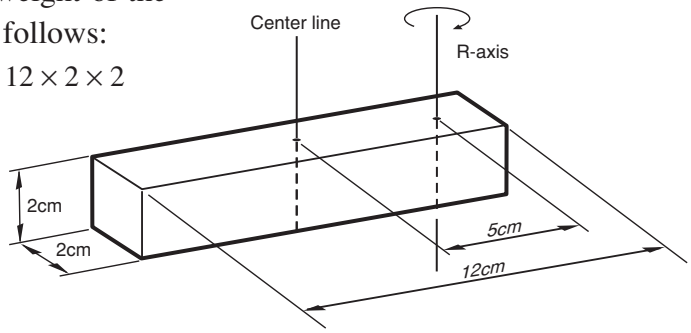


Fig. 3-20

The moment of inertia of the stay (Js) is then calculated from Eq. 3-7.

$$Js = \frac{0.37 \times (12^2+2^2)}{12 \times 980} + \frac{0.37 \times 5^2}{980} = 0.014 \text{ (kgfcmsec}^2\text{)}$$

2) Moment of inertia of the chuck

When the chuck form resembles that shown in Fig. 3-21, the weight of the chuck (Wc) is

$Wc = 0.0078 \times 2 \times 4 \times 6$

$= 0.37$ (kgf)

The moment of inertia of the chuck (Jc) is then calculated from Eq. 3-7.

$$Jc = \frac{0.37 \times (2^2+4^2)}{12 \times 980} + \frac{0.37 \times 10^2}{980}$$

$= 0.038$ (kgfcmsec^2)

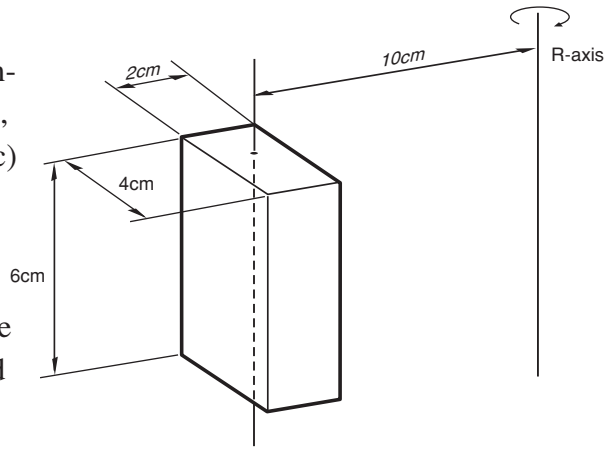


Fig. 3-21

3) Moment of inertia of workpiece

When the workpiece form resembles that shown in Fig. 3-22, the weight of the workpiece (Ww) is

$$Ww = \frac{\rho\pi D^2 h}{4} = \frac{0.0078\pi \times 2^2 \times 4}{4}$$

$= 0.098$ (kgf)

The moment of inertia of the workpiece (Jw) is then calculated from Eq. 3-5.

$$Jw = \frac{0.097 \times 2^2}{8 \times 980} + \frac{0.097 \times 10^2}{980}$$

$= 0.010$ (kgfcmsec^2)

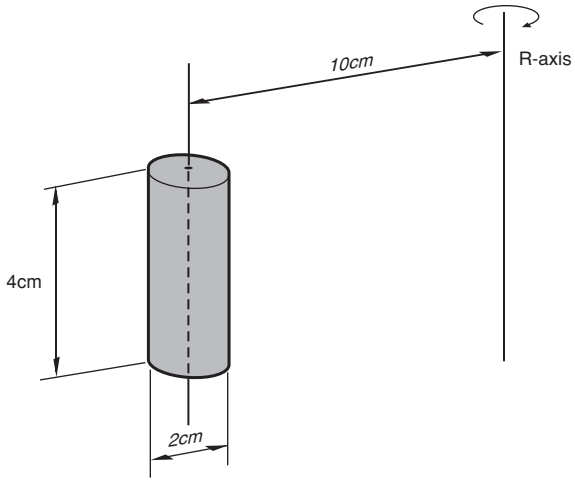


Fig. 3-22

4) Total weight

The total weight (W) is calculated as follows:

$W = Ws + Wc + Ww = 0.84$ (kgf)

5) Total moment of inertia

The total moment of inertia (J) is then obtained as follows:

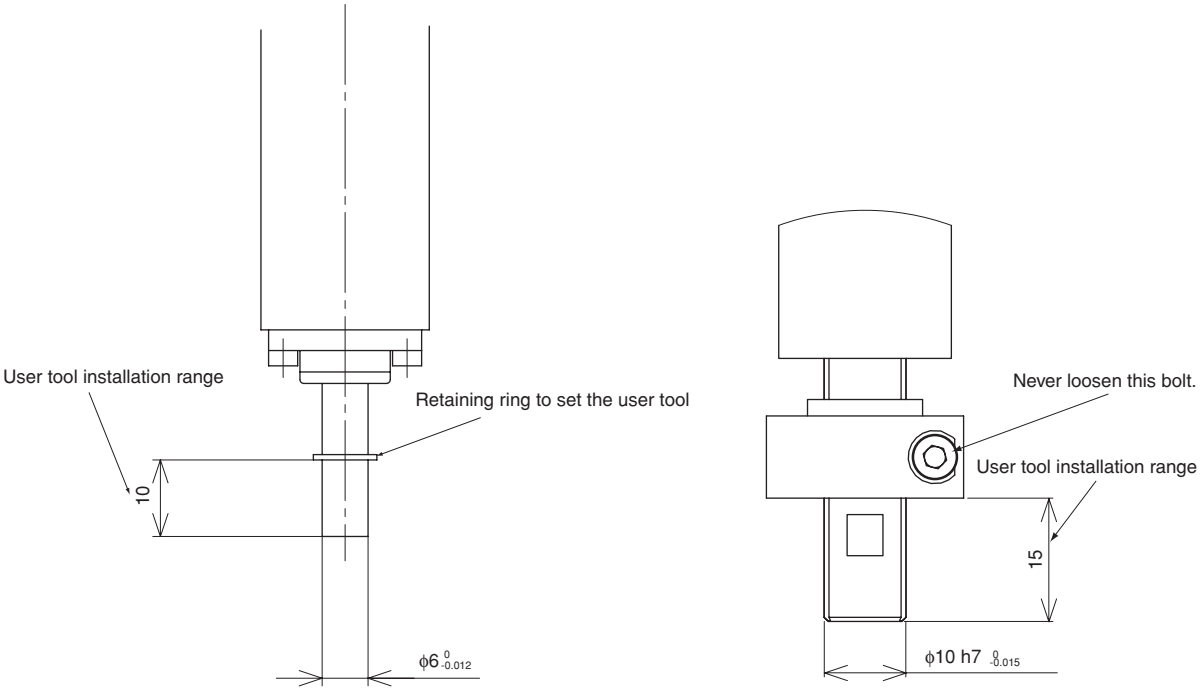
$J = Js + Jc + Jw = 0.062$ (kgfcmsec^2)

7-4 Attaching the end effector

⚠ WARNING

Before attaching the end effector, be sure to turn off the controller.

The manipulator part to which an end effector is attached must have adequate strength and rigidity, as well as gripping force to prevent positioning errors. Table 3-1 shows the maximum load that can be applied to the end effector attachment of each robot model. Recommended methods for attaching end effectors are shown in Table 3-2 and Fig. 3-25. Refer to Fig. 3-23 for details on the end effector attachment of each robot model.
When checking end effector operation, refer to "6 Trial Operation" in Chapter 1.



YK120X, YK150X YK180X, YK220X

Fig. 3-23 Z-axis tip shape

Table 3-1

	Fxymax		Fzmax		Frmax		Mrmax		Mmax	
Robot Mode	N	kgf	N	kgf	N	kgf	Nm	kgfm	Nm	kgfm
YK120X	27	2.8	6.7	0.7	9.8	1.0	0.5	0.05	0.4	0.04
YK150X	27	2.8	6.7	0.7	12	1.3	0.5	0.05	0.4	0.04
YK180X	27	2.8	6.7	0.7	15.7	1.6	4.5	0.46	0.9	0.09
YK220X	30	3.1	6.7	0.7	18.6	1.9	4.5	0.46	0.9	0.09

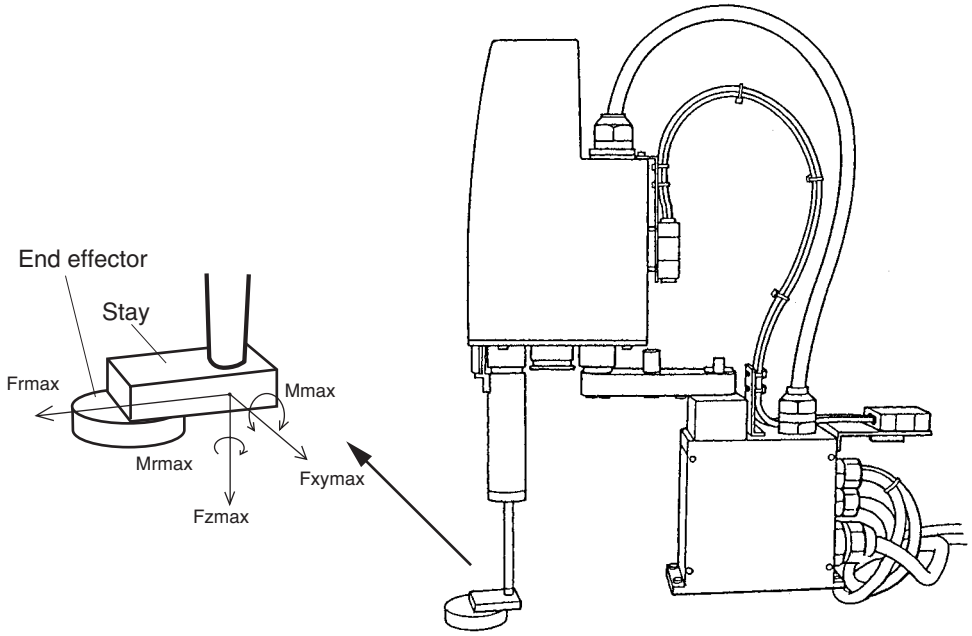


Fig. 3-24 Maximum load applied to end effector attachment

Table 3-2

Robot Mode	Bolts Used	Number of bolts	Tightening torque		diameter(mm)
			Nm	kgfcm	
YK120X, YK150X	M3 or lager	2 or more	2.0	20	6 $^{+0.012}_{0}$
YK180X, YK220X	M4 or lager	2 or more	4.5	46	10 $^{+0.015}_{0}$

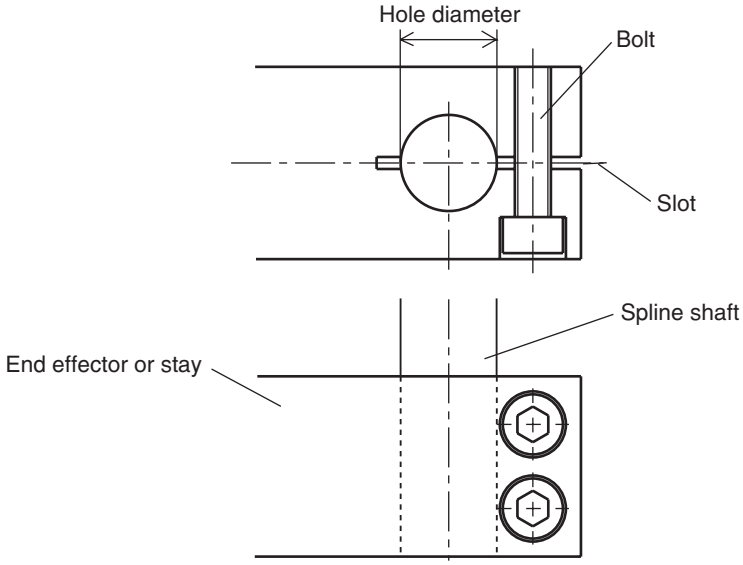


Fig. 3-25

⚠WARNING

The end effector attachment must have adequate strength to withstand the loads listed in Table 3-1. If too weak, the attachment may break during robot operation and fragments fly off causing accidents or injuries.

⚠WARNING

The end effector attachment must have sufficient rigidity versus the loads listed in Table 3-1. If this rigidity is inadequate, the end effector may vibrate during robot operation causing bad effects on the manipulator operation.

⚠WARNING

- When the end effector is attached by slot clamping, always observe the conditions listed in Table 3-2. If these are ignored, the end effector may come loose and fly off during robot operation, resulting in an accident or injury.
- In cases where other attachment methods are used, be sure that the end effector will not come off when the loads listed in Table 3-1 are applied.

⚠CAUTION

The YK120X series (YK120X, YK150X) and YK180X series (YK180X, YK220X) is designed to be compact, so the joints could be damaged if excessive force is applied, for example, during installation of an end effector.
Make sure that excessive force is not applied to the joints.

YK120X, YK150X

Axis	Tolerable radial load	Tolerable thrust load	Tolerable moment load	Tolerable torque
X-axis	100N (10.2kgf)	100N (10.2kgf)	1.5Nm (15.3kgfcm)	1.7Nm (17.3kgfcm)
Y-axis	45N (4.6kgf)	45N (4.6kgf)	0.45Nm (4.6kgfcm)	0.5Nm (5.1kgfcm)
R-axis	45N (4.6kgf)	45N (4.6kgf)	0.45Nm (4.6kgfcm)	0.3Nm (3.1kgfcm)

YK180X, YK220X

Axis	Tolerable radial load	Tolerable thrust load	Tolerable moment load	Tolerable torque
X-axis	275N (28.1kgf)	900N (91.8kgf)	6.0Nm (61.2kgfcm)	9.0Nm (91.8kgfcm)
Y-axis	150N (15.3kgf)	600N (61.2kgf)	3.3Nm (33.7kgfcm)	4.0Nm (40.8kgfcm)
R-axis	150N (15.3kgf)	600N (61.2kgf)	3.3Nm (33.7kgfcm)	2.2Nm (22.4kgfcm)

7-5 Gripping force of end effector

The gripping force of the end effector must have a sufficient extra margin of strength versus the workpiece weight and reaction force applied to the workpiece during robot operation.
The reaction force applied to the workpiece during operation can be calculated from the acceleration applied to the end effector attachment. The maximum acceleration on the end effector attachment of each robot model is listed in the table below. When the workpiece position is offset to the end effector attachment, the accelerations Amax and A_{XY}max become larger by an amount equal to the offset versus the arm length. When the R-axis rotates during operation, this acceleration $A_R$max must be taken into account.

Table 3-3 Maximum acceleration during robot operation

Robot Model	Amax(m/sec²)	A_{XY}max(m/sec²)	Azmax(m/sec²)	$A_R$max(rad/sec²)
YK120X	20	8.4	23	267
YK150X	25	11	16	267
YK180X	50	16	16	767
YK220X	61	19	16	767

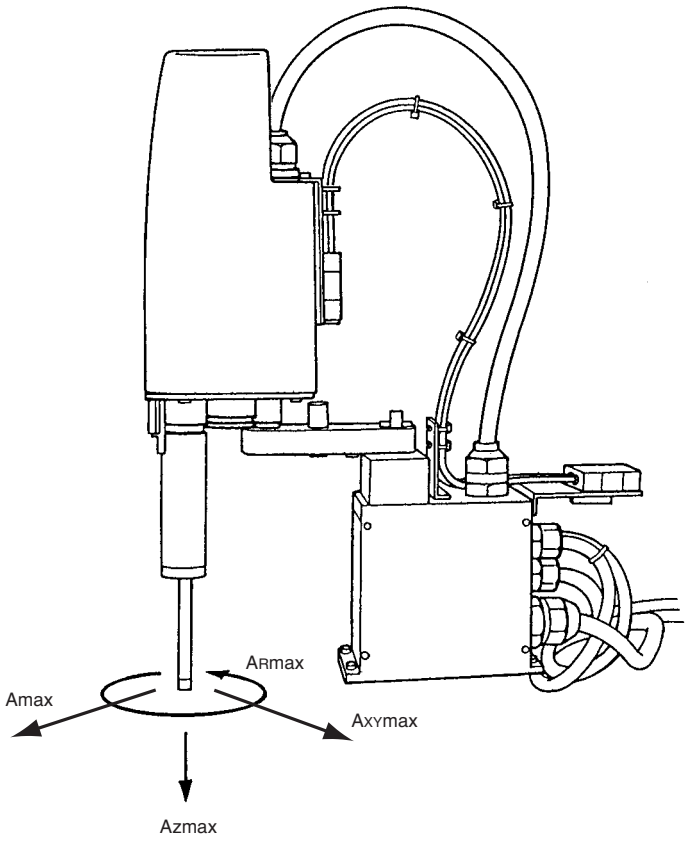


Fig. 3-26 Maximum acceleration on end effector attachment

⚠ WARNING

The gripping force of the end effector must have a sufficient extra margin of strength to prevent the workpiece from coming loose and flying off during robot operation.
If the gripping force is too weak, the workpiece may come loose and fly off causing accidents or injuries.

8 Working Envelope and Mechanical Stopper Positions for Maximum Working Envelope

Working envelope and mechanical stopper positions for the maximum working envelope of each robot are shown in "1-2 External view and dimensions" in Chapter 7.
An example using the YK120X is described below. (Refer to Fig. 7-1.) Other robot models are the same.

1) X and Y axes
   Do not attempt operation outside the working envelope. The working envelope described in this manual is an area with the robot frontal reference.

2) Z-axis
   Do not attempt work outside the working envelope. In particular, do not attempt work in the area between the working envelope and mechanical stopper position. Mechanical stoppers are installed at both the upper and lower ends of the movement range.

⚠ WARNING

The robot cable, user wiring or tubing may be damaged if the robot load interferes with them resulting in hazardous robot malfunctions. Do not operate at points where the load may interfere with the robot cable, user wiring or tubing.

3) R-axis
   The R-axis has no mechanical stoppers.

⚠ CAUTION

Since the R-axis has no mechanical stoppers, make certain that the end effector wiring and tubing do not become entangled during operation.

MEMO

CHAPTER 4

Adjustment

MEMO

1 Overview

YAMAHA robots have been completely adjusted at the factory or by the sales representative before shipment, including the origin position adjustment. If the operating conditions are changed and the robot must be adjusted, then follow the procedures described in this chapter.

2 Safety Precautions

(1) Read and understand the contents of this chapter completely before attempting to adjust the robot.

(2) Place a conspicuous sign indicating the robot is being adjusted, to prevent others from touching the controller switch, programming unit or operation panel.

(3) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off the movement area around the manipulator in place of a safeguard enclosure, and observe the following points.
①Use stable posts which will not fall over easily.
②The rope or chain should be easily visible by everyone around the robot.
③Place a conspicuous sign prohibiting the operator or other personnel from entering the movement area of the manipulator.

(4) To check operation after adjustment, refer to "6. Trial Operation" in Chapter 1.

3 Adjusting the origin

All models of the YK120X series and YK180X series robots use an absolute type position detector.
The origin position (zero pulse point) can be determined by absolute reset. Once absolute reset is performed, you do not have to repeat absolute reset when turning the power on next time.
However, absolute reset is required if any of the following cases occur. The robot is shipped from the factory in condition "c" (below), so please perform absolute reset after installing the robot. For more details on absolute reset, refer to "Absolute Reset" in Chapter 4 of the "YAMAHA robot controller owner's manual".

a. Absolute-related error occurred on the axis.
b. Power drop was detected in the absolute battery for the driver installed inside the robot controller.
c. Cable connecting the robot unit to the controller was disconnected. (This is the status when shipped from the factory.)
d. Robot generation was changed.
e. Parameters were initialized.
f. Axis parameters "Origin shift", "Origin method", "Origin direction" or "Motor direction" were changed.
g. Motor was replaced. (Motor wiring connector was removed.)
h. Data in the ALL data file (extension: ALL) or parameter file (extension: PRM) was written into the controller by way of the RS-232C.

The following sections explain how to perform absolute reset.

⚠CAUTION

If any of the above cases occur after installing the robot, absolute reset must be performed again. The robot must be moved to the origin position to perform absolute reset. Select a robot position where the origin position will not interfere with peripheral devices after setup is completed.

⚠CAUTION

After performing absolute reset, move the robot to a known point to check whether the origin position is correctly set. When doing this check, move the robot at the slowest possible speed.

The YK120X series and YK180X series absolute methods include the sensor method and stroke end method.
The YK120X series uses the stroke end method for the X-axis, Y-axis and Z-axis, and the sensor method for the R-axis.
The YK180X series uses the stroke end method for the Z-axis, and the sensor method for the X-axis, Y-axis and R-axis.

3-1 Absolute reset method

3-1-1 YK120X series (YK120X, YK150X)

3-1-1-1 Sensor method (R-axis)

In the sensor method, the target axis is automatically operated for the absolute reset, and the absolute reset is performed at the position where the proximity sensor provided on the target axis detects the detection area (dog).
The absolute reset in the sensor method can be executed with the teaching pendant (MPB), RS-232C communication, and dedicated input.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

⚠ CAUTION

The origin cannot be detected in any axis which is not positioned on the plus side from the origin (See Fig. 4-1.) before starting the return-to-origin operation. (Factory setting at shipment.)
In this case, press the STOP key to interrupt the return-to-origin operation, move the target axis to the plus side of the origin, and reperform the origin return operation.
If the return-to-origin operation is not stopped, the robot will continue moving and could collide with the peripheral devices. The R-axis does not have a mechanical stopper, so the wiring and piping installed on the end effector could become entangled.

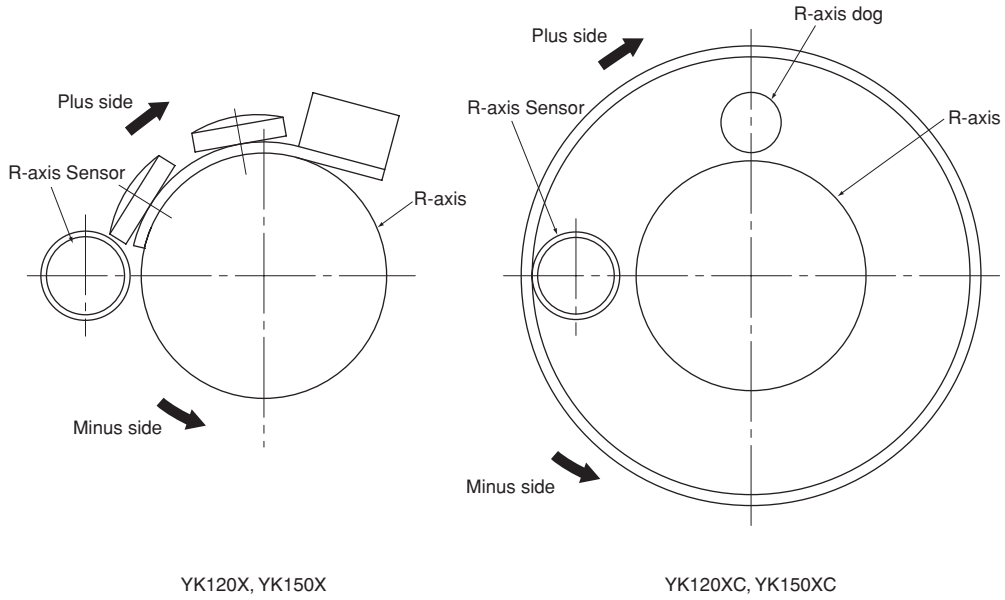


Fig. 4-1 View of R-axis from below

3-1-1-2 Stroke end method (X-axis, Y-axis)

With the stroke end method, the X and Y-axes are pushed against the mechanical stopper, and after the axis end is detected, absolute reset is performed from a position slightly back from the axis end.

⚠WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

⚠CAUTION

Before starting return-to-origin operation, move the X-axis to a position on the plus side from the origin position (See Fig. 4-2), and the Y-axis to a position on the minus side, so that the robot is positioned in a right-handed system as shown in Fig. 4-2.
When the return-to-origin operation starts, the X-axis will move to the minus side and the Y-axis will move to the plus side. After pushing against the mechanical stopper, the axes will return slightly, and the return-to-origin will be completed.
The X and Y-axes will move to the positions shown in Fig. 4-3 during return-to-origin, so make sure that the tool on the end, the robot and the peripheral devices do not interfere. The maximum tolerable load radius (when load is cylindrical object) is shown in Fig. 4-3. If return-to-origin is performed with a load larger than this radius installed on the R-axis, the base and load could interfere.

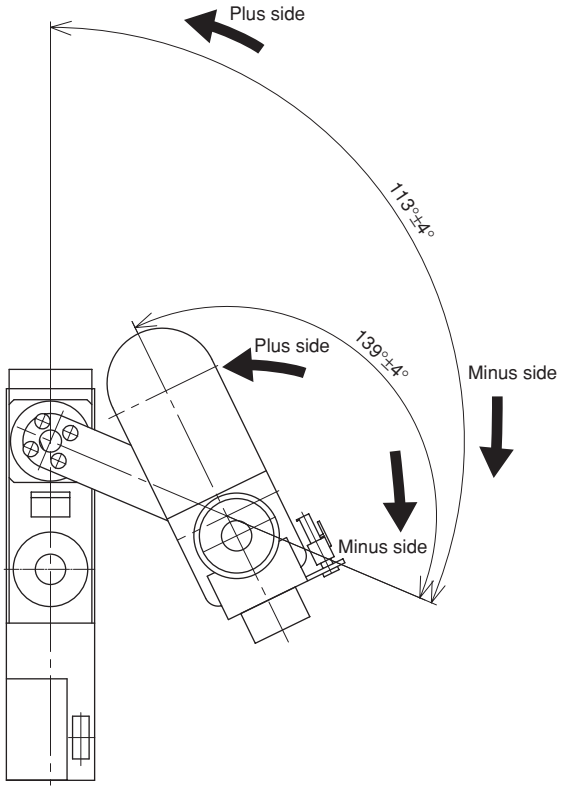


Fig. 4-2 Default origin position (YK120X, YK150X, YK120XC, YK150XC)

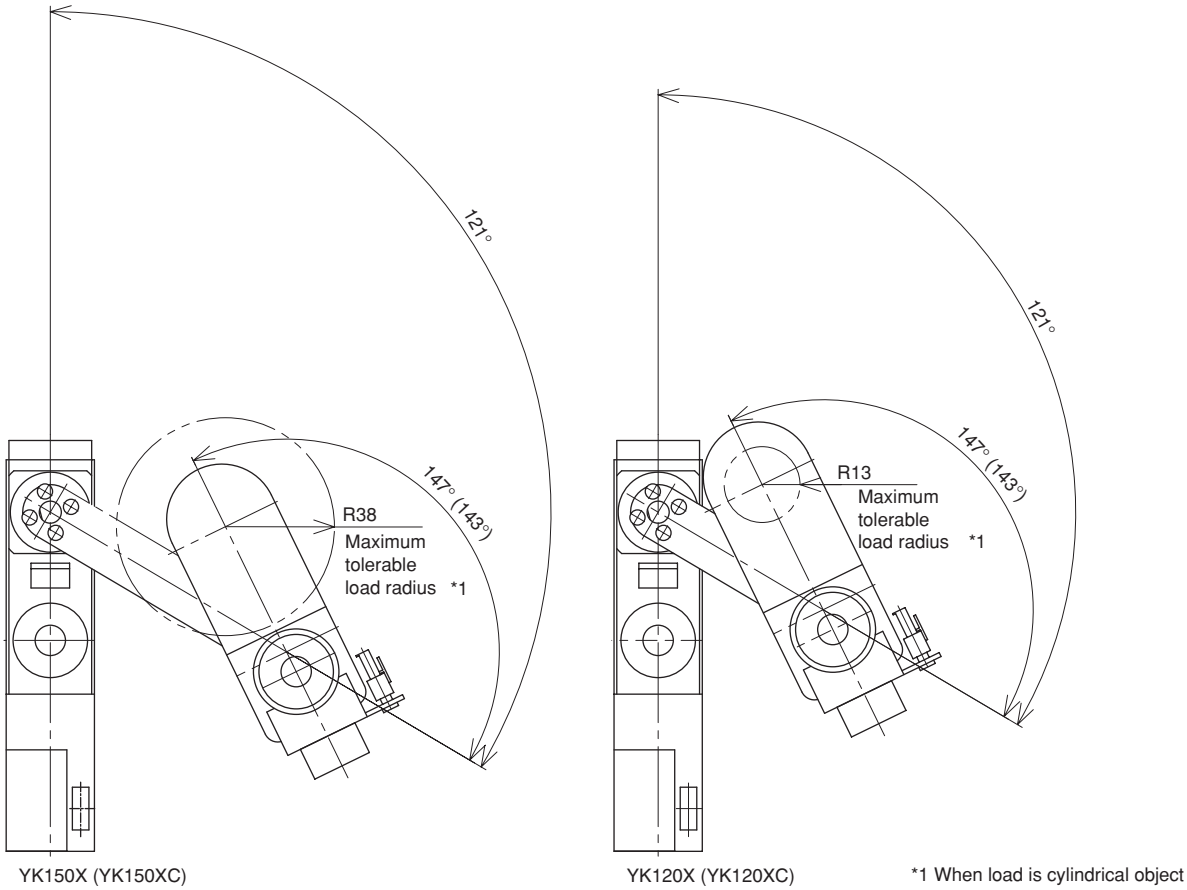


Fig. 4-3 X and Y-axis maximum movement position during X and Y-axis stopper origin position setting

3-1-1-3 Stroke end method (Z-axis)

With this method, the Z-axis is pushed against the mechanical stopper, and after the axis end is detected, absolute reset is performed from a position slightly back from the axis end.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

3-1-2 YK180X series (YK180X, YK220X)

3-1-2-1 Sensor method (R-axis)

In the sensor method, the target axis is automatically operated for the absolute reset, and the absolute reset is performed at the position where the proximity sensor provided on the target axis detects the detection area (dog).
The absolute reset in the sensor method can be executed with the teaching pendant (MPB), RS-232C communication, and dedicated input.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

⚠ CAUTION

The origin cannot be detected in any axis which is not positioned on the plus side from the origin (See Fig. 4-4.) before starting the return-to-origin operation. (Factory setting at shipment.)
In this case, press the STOP key to interrupt the return-to-origin operation, move the target axis to the plus side of the origin, and reperform the origin return operation.
If the return-to-origin operation is not stopped, the robot will continue moving and could collide with the peripheral devices. The R-axis does not have a mechanical stopper, so the wiring and piping installed on the end effector could become entangled.

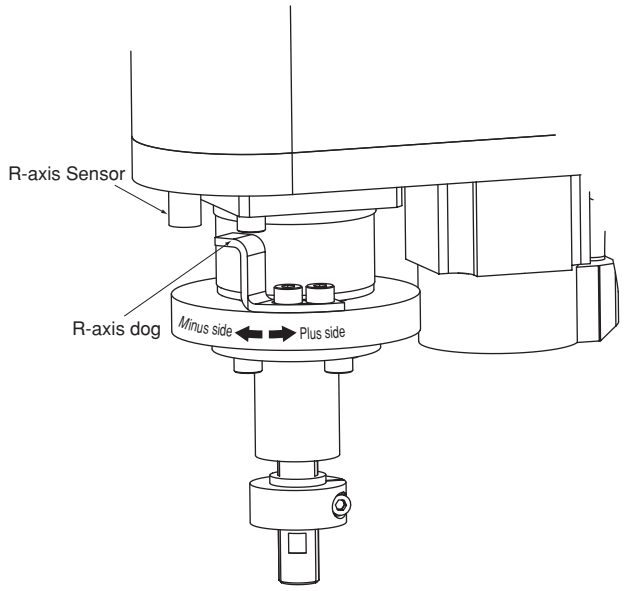


Fig. 4-4

3-1-2-2 Sensor method (X-axis, Y-axis)

⚠WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

⚠CAUTION

The origin cannot be detected in any axis which is not positioned on the plus side from the origin (See Fig. 4-5.) before starting the return-to-origin operation. (Factory setting at shipment.)
In this case, press the STOP key to interrupt the return-to-origin operation, move the target axis to the plus side of the origin, and reperform the origin return operation.
If the return-to-origin operation is not stopped, the robot will continue moving and could collide with the peripheral devices.
The X and Y-axes will move to the positions shown in Fig. 4-5 during return-to-origin, so make sure that the tool on the end, the robot and the peripheral devices do not interfere. The maximum tolerable load radius (when load is cylindrical object) is shown in Fig. 4-5. If return-to-origin is performed with a load larger than this radius installed on the R-axis, the base and load could interfere.
Since the X-axis arm first returns to the origin, the tool on the end might interfere with the robot base (pedestal) if the Y-axis arm is near its origin.

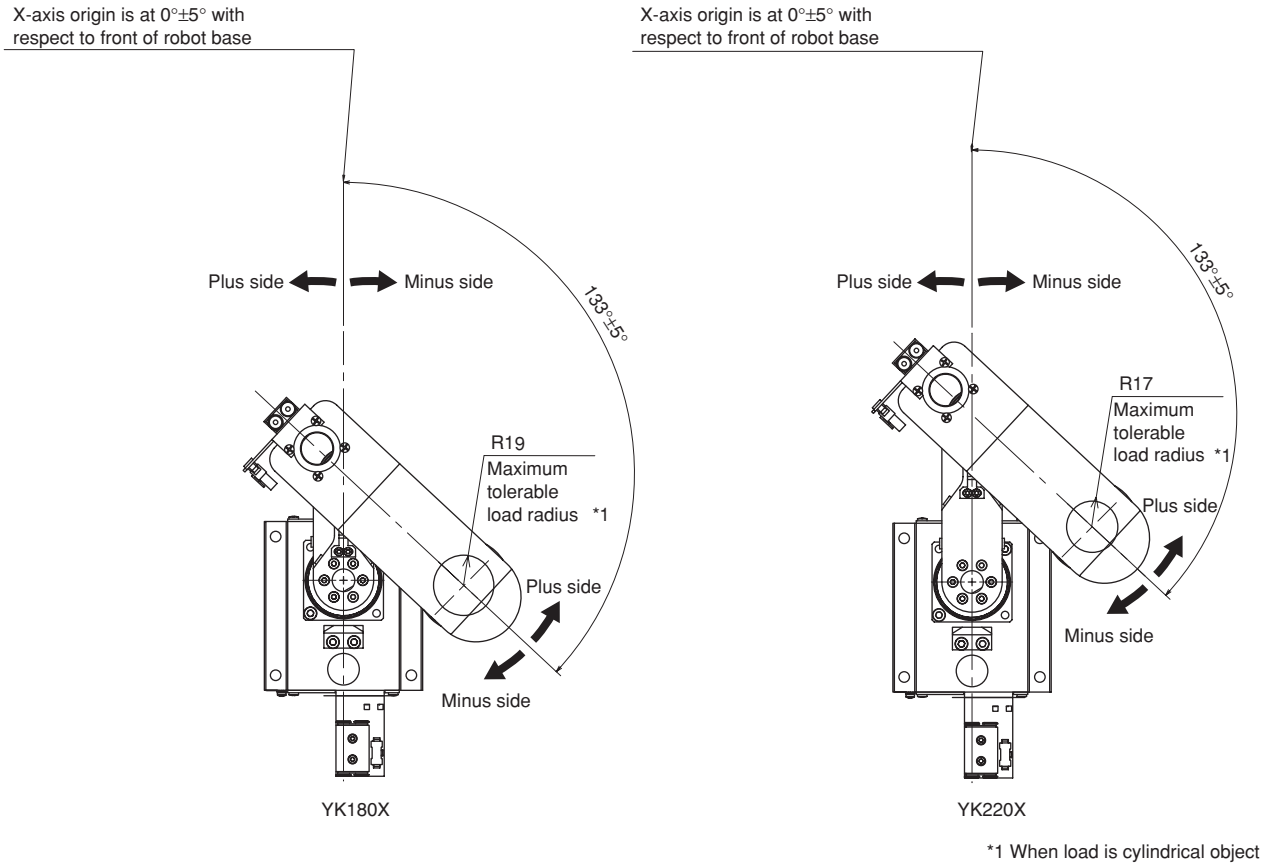


Fig. 4-5 Default origin position

3-1-2-3 Stroke end method (Z-axis)

With this method, the Z-axis is pushed against the mechanical stopper, and after the axis end is detected, absolute reset is performed from a position slightly back from the axis end.

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

3-2 Machine reference

The YK-X Series position detector uses a resolver having one position that can perform absolute reset in respect to one motor rotation.
When absolute reset is performed with the sensor method or stroke end method, the origin position will be set to a position where it can be reset immediately after the origin sensor reacts to the dog (where the origin signal is detected) or the stroke end (mechanical stopper) is detected.
The machine reference means the position relationship between the position where the robot detects the origin signal and the position where the absolute reset can be performed soon after the origin signal detection. (See Fig. 4-6.) The machine reference is expressed in the ratio of interval A to interval B shown in Fig. 4-6. Interval A is the minimum distance between the positions where absolute reset can be performed and interval B is the distance between the position where the origin signal is detected and the position where absolute reset can be performed soon after the origin signal detection.
The machine reference value is displayed on the optional MPB screen. (Unit: %)

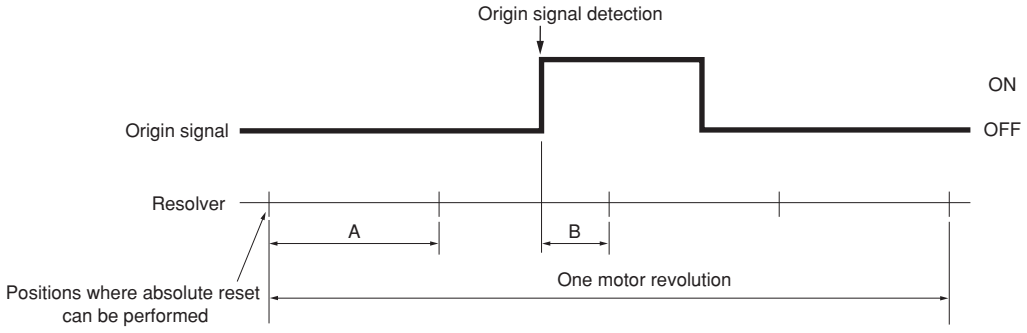
Machine reference value = B/A × 100(%)

⚠CAUTION

It is necessary for the machine reference to be adjusted in a specified range in order to keep the repeatability precision of the absolute reset position. (Factory-adjusted at shipment.)
Refer to "Chapter 4, 3-4 Adjusting the machine reference" for the machine reference adjustment method .

Recommended machine reference value: 40 to 60% (26 to 74% only for Z-axis)

Machine reference



Machine reference display on MPB screen

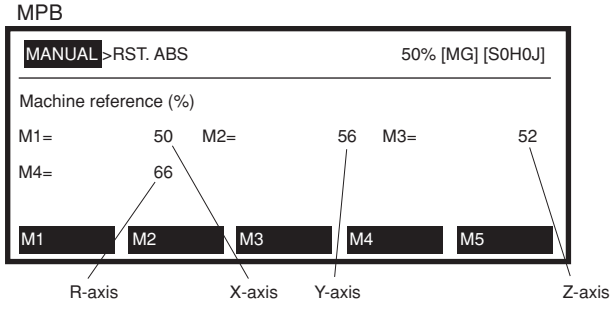


Fig. 4-6

3-3 Absolute reset procedures

3-3-1 Sensor method (R-axis)

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.)
See the "YAMAHA robot controller owner's manual" for information on operating the robot controller.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select the R-axis for absolute reset. (R-axis: M4)
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

⚠ CAUTION

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

6) Confirm that the R-axis, to perform absolute reset, is at a position on the plus side of the origin (See Fig. 4-1, Fig. 4-4).
If it is not at the plus side, then press the jog key to move the target axis to the plus side.
When performing absolute reset for the other axes at the same time, confirm that the other axes are also at an appropriate position. (Refer to procedures for absolute reset of other axes)

7) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

8) After the absolute reset is completed, check that the R-axis machine reference value displayed on the MPB is between 40 and 60 (recommended range). If the machine reference value is outside the recommended range, then the next absolute reset may not be properly performed.
In this case, refer to "3-4 Adjusting the machine reference", and make the necessary adjustments.

3-3-2 Stroke end method (X and Y axes of YK120X, YK150X)

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.)
See the "YAMAHA robot controller owner's manual" for information on operating the robot controller.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select the X-axis or Y-axis for absolute reset. (X-axis: M1, Y-axis: M2)
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

⚠ CAUTION

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

6) Confirm that the X-axis is at a position on the plus side of the origin (See Fig. 4-2), and that the Y-axis is at the minus side. Make sure that the robot is positioned in a right-handed system as shown in Fig. 4-2. If the axes are not at these positions, press the jog keys, etc., and move the target axes. When performing absolute reset for the other axes at the same time, confirm that the other axes are also at an appropriate position. (Refer to procedures for absolute reset of other axes)

7) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

8) After the absolute reset is completed, check that the X-axis and Y-axis machine reference value displayed on the MPB is within the absolute reset tolerance range (40 to 60).
If the machine reference value is outside the absolute reset tolerance range, then the next absolute reset may not be properly performed.
In this case, refer to "Chapter 4, 3-4 Adjusting the machine reference" and make the necessary adjustments.

3-3-3 Stroke end method (Z-axis)

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.)
See the "YAMAHA robot controller owner's manual" for information on operating the robot controller.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select M3 (Z-axis). (Z-axis: M3)
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

6) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

7) After the absolute reset is completed, check that the machine reference value displayed on the MPB is within the absolute reset tolerance range (26 to 74).
If the machine reference value is outside the absolute reset tolerance range, then the next absolute reset may not be properly performed.
In this case, refer to "Chapter 4, 3-4 Adjusting the machine reference" and make the necessary adjustments.

3-3-4 Sensor method (X and Y axes of YK180X, YK220X)

⚠ WARNING

Serious injury might occur from physical contact with the robot during operation.
Never enter within the robot movement range during absolute reset.

The operation procedure using the MPB is described next. (Press the ESC key on the MPB if you want to return to the preceding step.)
See the "YAMAHA robot controller owner's manual" for information on operating the robot controller.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from touching the controller switch or operation panel.

3) Set the controller to MANUAL mode, if not in MANUAL mode.

4) Press the F13 (LOWER+F3) key to select "RST. ABS".

5) Select the X-axis or Y-axis for absolute reset. (X-axis: M1, Y-axis: M2)
To perform absolute reset on all axes, select "ALL" with the F11 (LOWER+F1) key.

⚠ CAUTION

The Z-axis of the stroke end method first rises during the absolute reset of all axes (default setting). Be careful that your fingers do not get pinched or crushed by any sudden movement.

6) Move the X and Y axes to a position on the plus side of their origins (See Fig. 4-5) so that the robot is positioned in a left-handed system as shown in Fig. 4-5. If the axes are not at these positions, press the jog keys, etc. and move the target axes. When performing absolute reset for the other axes at the same time, check that the other axes are also at an appropriate position. (Refer to procedures for absolute reset of other axes.)

7) Since the message "Reset ABS encoder OK?" is displayed, check that there are not any obstacles in the robot movement range, and press the F4 key (YES).

8) After the absolute reset is completed, check that the X-axis and Y-axis machine reference value displayed on the MPB is within the absolute reset tolerance range (40 to 60).
If the machine reference value is outside the absolute reset tolerance range, then the next absolute reset may not be properly performed.
In this case, refer to "Chapter 4, 3-4 Adjusting the machine reference" and make the necessary adjustments.

3-4 Adjusting the machine reference

⚠CAUTION

If any machine reference is adjusted, the origin position may change.
Before the adjustment, mark off the reference mark at the current origin position on the main body of the robot.
After the machine reference is adjusted, be sure to check that the origin position has not deviated.
If the origin position changes after the machine reference has been adjusted, then the standard coordinate and point data must be reset.

⚠CAUTION

When the arm moves at high speed and strikes against a mechanical stopper violently, the machine reference value may change. If this has happened, check the machine reference value. Also check the mechanical stopper for any damage and the origin position for shift. If the machine reference value is outside the recommended range, adjust the machine reference. In this case, re-teaching may be required if the origin position has shifted.

3-4-1 YK120X series (YK120X, YK150X)

3-4-1-1 Adjusting the R-axis machine reference (YK120X, YK150X)

The adjustment method for the R-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Phillips-head screwdriver

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the R-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the R-axis is touched.

8) Using a Phillips screwdriver, loosen the two screws fixing the dog at the R-axis joint. (See Fig. 4-7.)

⚠CAUTION

The screw only needs to be loosened and does not need to be removed completely.

9) Move the dog in the following manner.
   When machine reference < 40%: Move dog in A direction
   When machine reference > 60%: Move dog in B direction
   The movement guide is 2.3mm/100%.

10) Tighten the screw and fix the dog.

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After the absolute reset is completed, read the machine reference value displayed on the MPB.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted.
If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

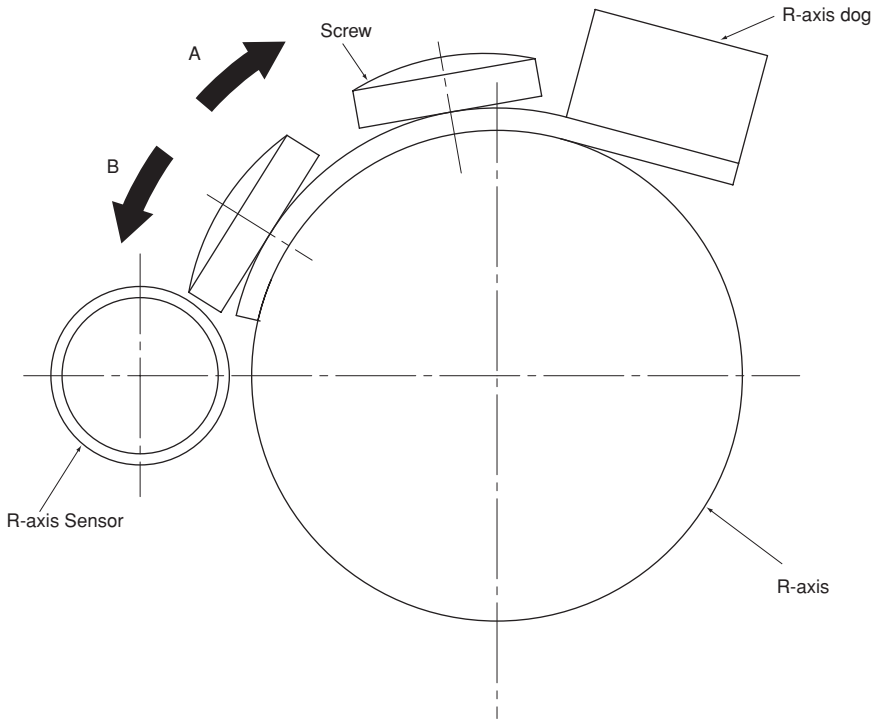


Fig. 4-7 Adjustment of R-axis machine reference (View from below)

3-4-1-2 Adjusting the R-axis machine reference (YK120XC, YK150XC)

The adjustment method for the R-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Hex wrench set

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the R-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the R-axis is touched.

8) Using a hex wrench, loosen the set screws (4 pieces) securing the dog ring to the R-axis joint. (See Fig. 4-8.)

⚠CAUTION

The set screws only need to be loosened, and do not need to be completely removed.

9) Move the dog ring in the following manner.
   When machine reference < 40%: Move dog ring in A direction
   When machine reference > 60%: Move dog ring in B direction
   The movement guide is 2.9mm/100%.

10) Tighten the set screws to secure the dog ring. Rotate the R-axis by hand to check that the dog and sensor do not come in contact with each other. (See Fig. 4-8.)

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After the absolute reset is completed, read the machine reference value displayed on the MPB.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted.
If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

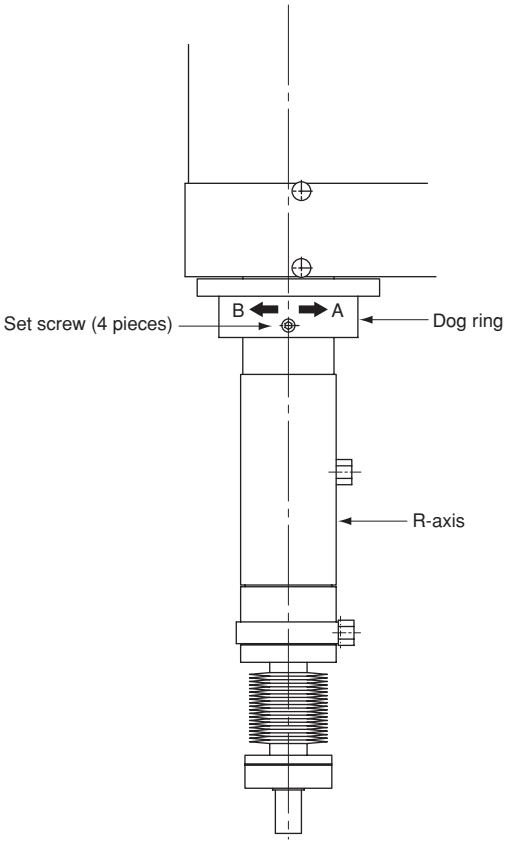


Fig. 4-8 Adjustment of R-axis machine reference

3-4-1-3 Adjusting the X-axis machine reference

The adjustment method for the X-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Hex wrench set

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the X-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the X-axis arm is touched.

8) Using a hexagon wrench, loosen the two bolts fixing the X-axis movable mechanical stopper. (See Fig. 4-9.)

⚠CAUTION

The bolt only needs to be loosened, and does not need to be completely removed.

9) Move the movable mechanical stopper in the following manner.
   When machine reference < 40% :
   Move mechanical stopper in A direction
   When machine reference > 60% :
   Move mechanical stopper in B direction
   The movement guide is 2.2mm/100%.

10) Tighten the bolt and fix the movable mechanical stopper. The tightening torque is 4.4kgfcm (0.43Nm).

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After completing absolute reset, check the machine reference value.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

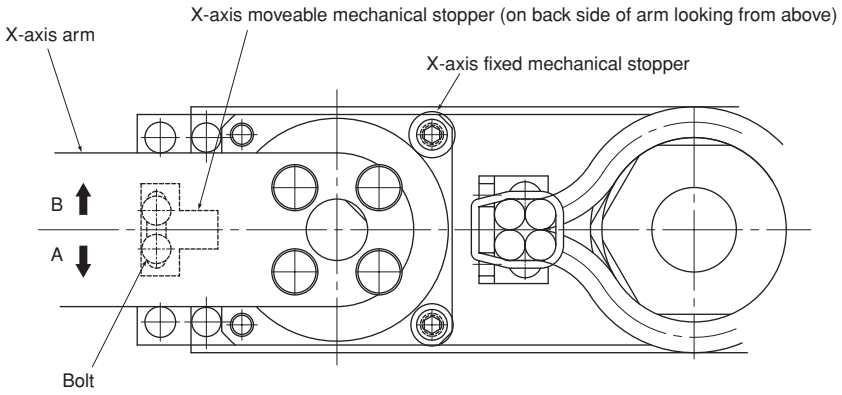


Fig. 4-9 Adjustment of X-axis machine reference

3-4-1-4 Adjusting the Y-axis machine reference

The adjustment method for the Y-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Hex wrench set

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the Y-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the Y-axis arm is touched.

8) Using a hexagon wrench, loosen the two bolts fixing the Y-axis movable mechanical stopper. (See Fig. 4-10.)

⚠CAUTION

The bolt only needs to be loosened, and does not need to be completely removed.

9) Move the movable mechanical stopper in the following manner.
   When machine reference < 40% :
   Move mechanical stopper in A direction
   When machine reference > 60% :
   Move mechanical stopper in B direction
   The movement guide is 3.5mm/100%.

10) Tighten the bolt and fix the movable mechanical stopper. The tightening torque is 4.4kgfcm (0.43Nm).

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After completing absolute reset, check the machine reference value.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

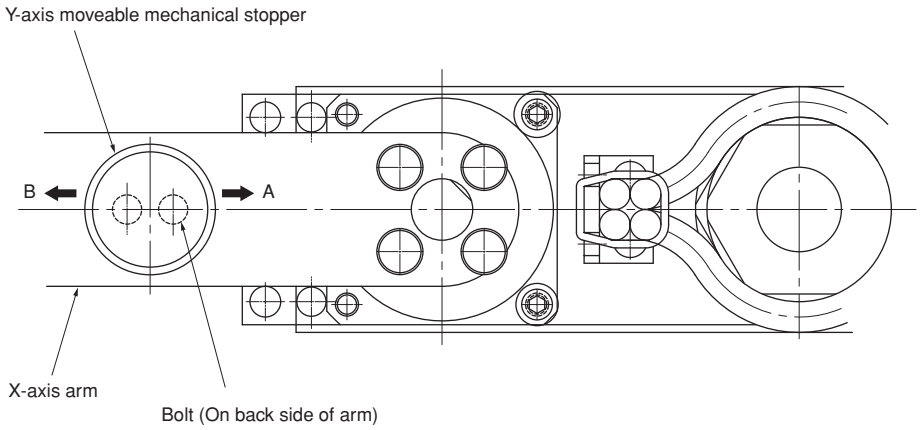


Fig. 4-10 Adjustment of Y-axis machine reference

3-4-1-5 Adjusting the Z-axis machine reference

The stroke end method is employed on the YK120X series robots for the absolute reset of the Z-axis.
The origin position of the Z-axis is fixed at the upper end of the Z-axis stroke, and it cannot be changed.
The machine reference is factory-adjusted at shipment, and readjustment is not necessary for normal use.
The readjustment in the following procedure is required, however, if the machine reference exceeds the tolerance range (26 to 74) of the absolute reset for any reason.

⚠CAUTION

The origin position may change when the machine reference amount is adjusted.
The point data must be reset after adjusting the machine reference.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

3) Perform the Z-axis absolute reset.
   To perform the Z-axis absolute reset, see "3-3-3 Stroke end method (Z-axis)" in Chapter 4.

4) Turn off the controller.

5) Enter the safeguard enclosure.

6) Remove the Y-axis upper cover.
   To remove the covers, see "7 Removing the Robot Covers" in Chapter 4.
   Place the upper cover on the robot base (pedestal) side with the machine harness still connected.

7) Confirm that the Z-axis rising end mechanical stopper is at the position shown in Fig. 4-11 (a).
   If not at that position, loosen the bolt and fix the stopper at the position shown in the drawing. The tightening torque is 4.4kgfcm (0.43Nm).
   Carry out steps 1) to 3) after fixing the mechanical stopper again.
   After completing absolute reset, check to see if the machine reference value is within the tolerance range for absolute reset. When within the tolerance range, turn off the controller power switch and reinstall the Y-axis upper cover to complete the work.

8) If the machine reference value is not within the tolerance range (26 to 74%) perform the following steps.

⚠ WARNING

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation.

- Press the emergency stop button and prop up the Z-axis with a support stand before releasing the brake.

9) With the robot controller's power ON, apply emergency stop on the controller and release the Z-axis brakes. Refer to the "YAMAHA Robot Controller owner's manual" for details on emergency stop, releasing emergency stop, releasing the Z-axis brakes and turning the brakes ON.

10) Loosen the set screw (two screws on upper side) fixing the ball screw in Fig. 4-11 (b), and change the phase of the ball screw in respect to the sleeve as shown below.
When machine reference $\leqq$ 5%:
Turn ball screw 180° clockwise looking from above
When 5% < machine reference < 26%:
Turn ball screw 90° clockwise looking from above
When 74% < machine reference < 90%:
Turn ball screw 90° counterclockwise looking from above
When 90% $\leqq$ machine reference:
Turn ball screw 180° counterclockwise looking from above

11) Tighten the set screw and fix the ball screw. The tightening torque is 17kgfcm (1.7Nm).

12) Exit the safeguard enclosure.

13) Confirm that there no workers in the safeguard enclosure, and then release the controller emergency stop state.

14) After completing absolute reset for the Z-axis, check to see if the machine reference value is within the tolerance range for absolute reset.

15) Turn the controller power OFF.

16) Install the Y-axis arm upper cover.

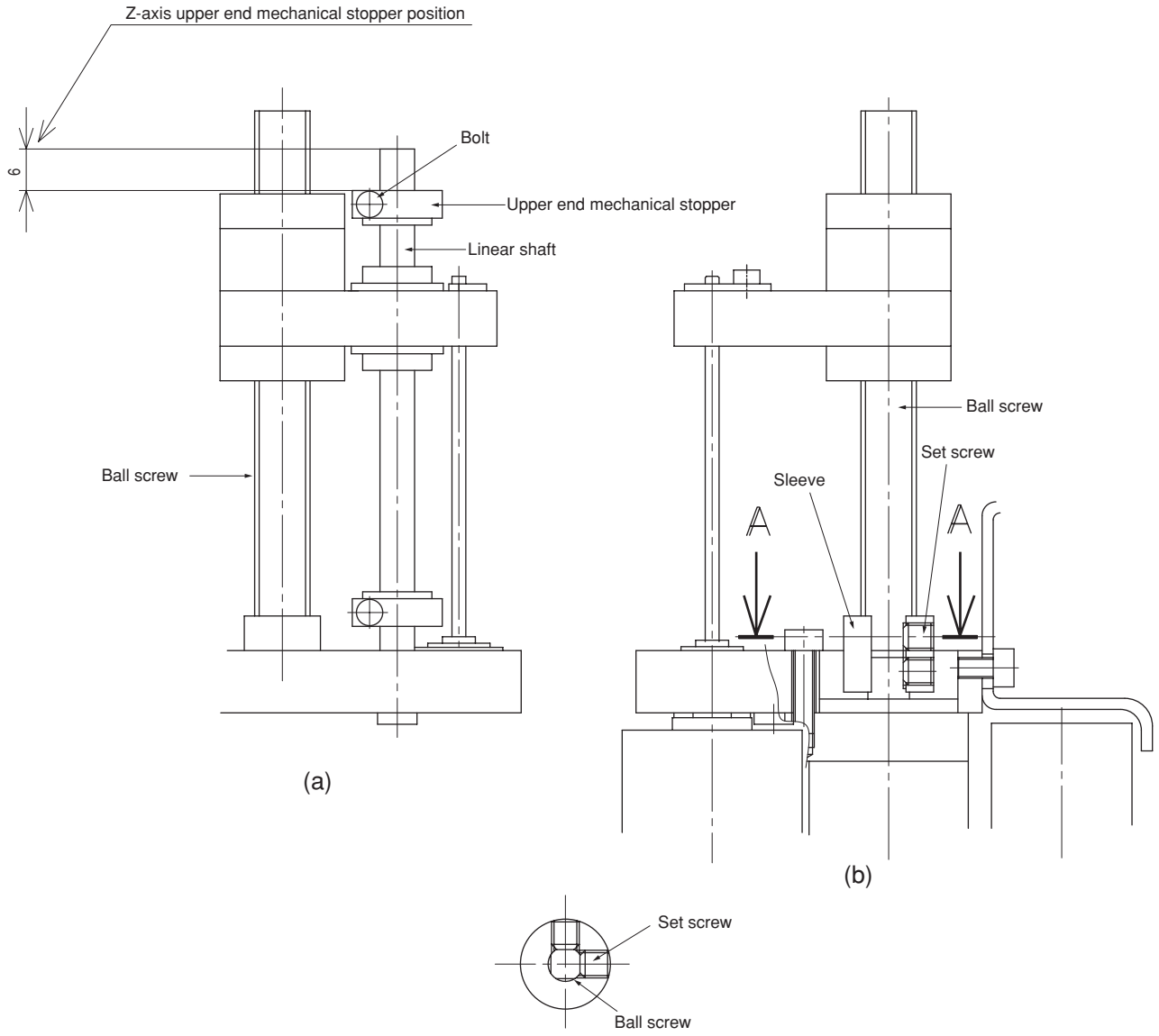

Z-axis upper end mechanical stopper position
6
Bolt
Upper end mechanical stopper
Linear shaft
Ball screw
(a)
Ball screw
Set screw
Sleeve
A
A
(b)
Set screw
Ball screw
Section A–A
(c)

Fig. 4-11

3-4-2 YK180X series (YK180X, YK220X)

3-4-2-1 Adjusting the R-axis machine reference (YK180X, YK220X)

The adjustment method for the R-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Phillips-head screwdriver

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the R-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the R-axis is touched.

8) Using a hex wrench, loosen the bolts (2 pieces) securing the dog on the R-axis joint. (See Fig. 4-12.)

⚠CAUTION

The bolt only needs to be loosened, and does not need to be completely removed.

9) Move the dog in the following manner.
   When machine reference < 40%: Move dog in A direction
   When machine reference > 60%: Move dog in B direction
   The movement guide is 0.8mm/100%.

10) Tighten the screw and fix the dog.

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After the absolute reset is completed, read the machine reference value displayed on the MPB.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted.
If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

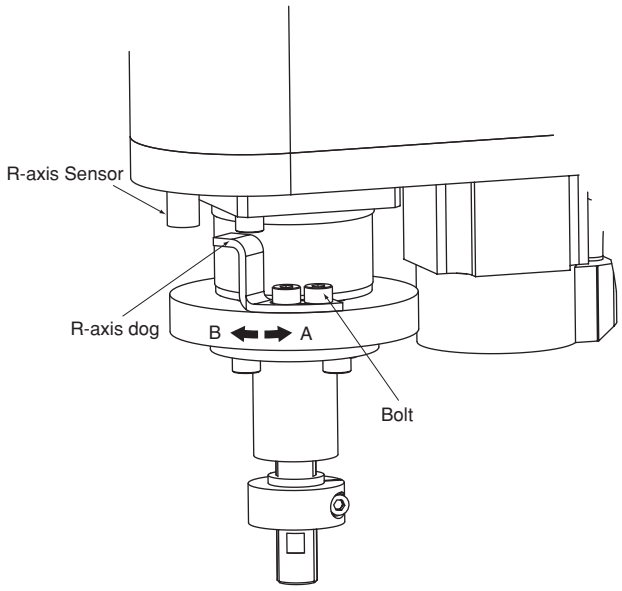


Fig. 4-12

3-4-2-2 Adjusting the X-axis machine reference

The adjustment method for the X-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Hex wrench set

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the X-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the X-axis arm is touched.

8) Using a hex wrench, loosen the bolts (2 pieces) securing the X-axis dog. (See Fig. 4-13.)

⚠CAUTION

The bolt only needs to be loosened, and does not need to be completely removed.

9) Move the movable mechanical stopper in the following manner.
   When machine reference < 40% :
   Move mechanical stopper in A direction
   When machine reference > 60% :
   Move mechanical stopper in B direction
   The movement guide is 1mm/100%.

10) Tighten the bolt and fix the movable mechanical stopper. The tightening torque is 20kgfcm (2.0Nm).

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After completing absolute reset, check the machine reference value.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

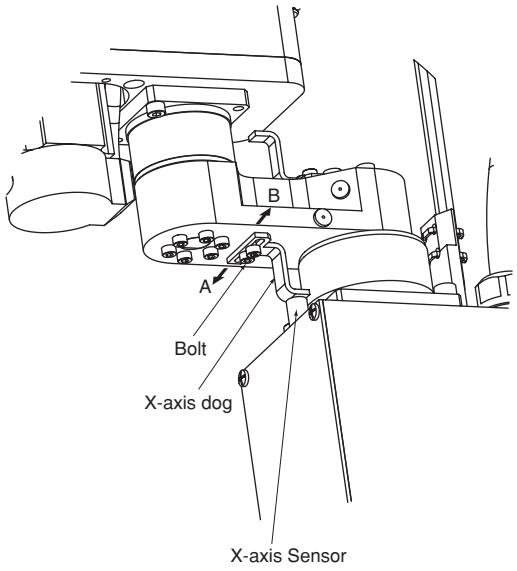


Fig. 4-13 Adjustment of X-axis machine reference

3-4-2-3 Adjusting the Y-axis machine reference

The adjustment method for the Y-axis machine reference is as follows.

1) Prepare the necessary tools.
   • Hex wrench set

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Perform the absolute reset from outside the safeguard enclosure.
   Refer to "3-3 Absolute reset procedures" for information about the absolute reset method.

4) If any machine reference value displayed on the MPB is not in the range between 40 and 60 (recommended range) after the absolute reset has been completed, then proceed with the following adjustment procedure.

5) Place a sign indicating that the robot is being adjusted in order to keep others from operating the controller or operation panel.

6) Turn off the controller and enter the safeguard enclosure.

7) Mark off the reference mark at the current origin position on the Y-axis joint area of the robot.
   At this time, be careful to prevent the origin position from deviating since the Y-axis arm is touched.

8) Using a hex wrench, loosen the bolts (2 pieces) securing the Y-axis dog. (See Fig. 4-14.)

⚠CAUTION

The bolt only needs to be loosened, and does not need to be completely removed.

9) Move the movable mechanical stopper in the following manner.
   When machine reference < 40% :
   Move mechanical stopper in A direction
   When machine reference > 60% :
   Move mechanical stopper in B direction
   The movement guide is 1.1mm/100%.

10) Tighten the bolt and fix the movable mechanical stopper. The tightening torque is 20kgfcm (2.0Nm).

11) Go out of the safeguard enclosure, and check that no one is inside the safeguard enclosure. Then turn on the controller.

12) Perform the absolute reset from outside the safeguard enclosure.

13) After completing absolute reset, check the machine reference value.

14) If the machine reference value is in the range between 40 and 60 (recommended range), then the machine reference has been completely adjusted. If it is outside the recommended range, then repeat the procedure that starts in 5) to readjust it.

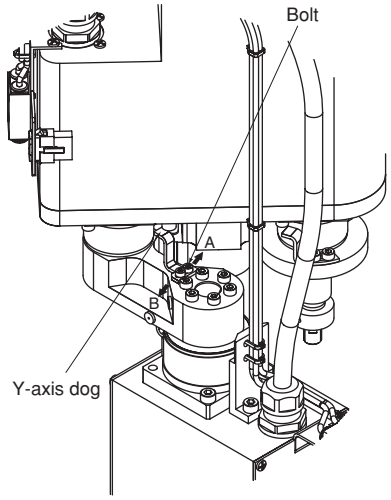


Fig. 4-14 Adjustment of Y-axis machine reference

3-4-2-4 Adjusting the Z-axis machine reference

The stroke end method is employed on the YK180X series robots for the absolute reset of the Z-axis.
The origin position of the Z-axis is fixed at the upper end of the Z-axis stroke, and it cannot be changed.
The machine reference is factory-adjusted at shipment, and readjustment is not necessary for normal use.
The readjustment in the following procedure is required, however, if the machine reference exceeds the tolerance range (26 to 74) of the absolute reset for any reason.

⚠CAUTION

The origin position may change when the machine reference amount is adjusted.
The point data must be reset after adjusting the machine reference.

1) Check that the Z-axis upper-end mechanical stopper is at the position shown in Fig. 4-15.
   If not, loosen the bolt and adjust the mechanical stopper to the specified position. Retighten the bolt to a torque of 20kgfcm (2.0Nm).

2) Check that no one is inside the safeguard enclosure, and then turn on the controller.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Perform the Z-axis absolute reset.
   To perform the Z-axis absolute reset, see "3-3-3 Stroke end method (Z-axis)" in Chapter 4.

5) After completing absolute reset, check to see if the machine reference value is within the tolerance range for absolute reset. When within the tolerance range (26 to 74%), the distance between the upper end urethane damper and the lower end of the spline nut is approximately 5mm.

6) If the machine reference value is not within the tolerance range, perform the following steps.

7) Turn off the controller.

8) Enter the safeguard enclosure.

9) Remove the Y-axis upper cover.
To remove the covers, see "7 Removing the Robot Covers" in Chapter 4.
Place the upper cover on the robot base (pedestal) side with the machine harness still connected.

⚠ WARNING

The Z-axis will slide down during the following work, causing a hazardous situation.
Prop up the Z-axis with a support stand before beginning the work.

10) Lift up the lower end urethane damper and loosen the bolts (6 pieces) securing the ball screw shown in Fig. 4-15. Then rotate the ball screw with respect to the Z-axis motor so that the distance between the upper end urethane damper and the lower end of the spline is 5mm. When the lower end position of the ball screw is determined, push the ball screw in so that it makes contact with the bottom of the Z-axis motor installation hole.

11) Tighten the bolts to secure the ball screw. The tightening torque should be 20kgfcm (2.0Nm).
Tighten the bolts a little at a time in a diagonal pattern. Otherwise, the ball screw might be off-center. After tightening the bolts securely, lower the lower end urethane damper.

12) Exit the safeguard enclosure.

13) Check that no one is inside the safeguard enclosure, and then turn on the controller.

14) After completing absolute reset for the Z-axis, check to see if the machine reference value is within the tolerance range for absolute reset.

15) Turn the controller power OFF.

16) Install the Y-axis arm upper cover.

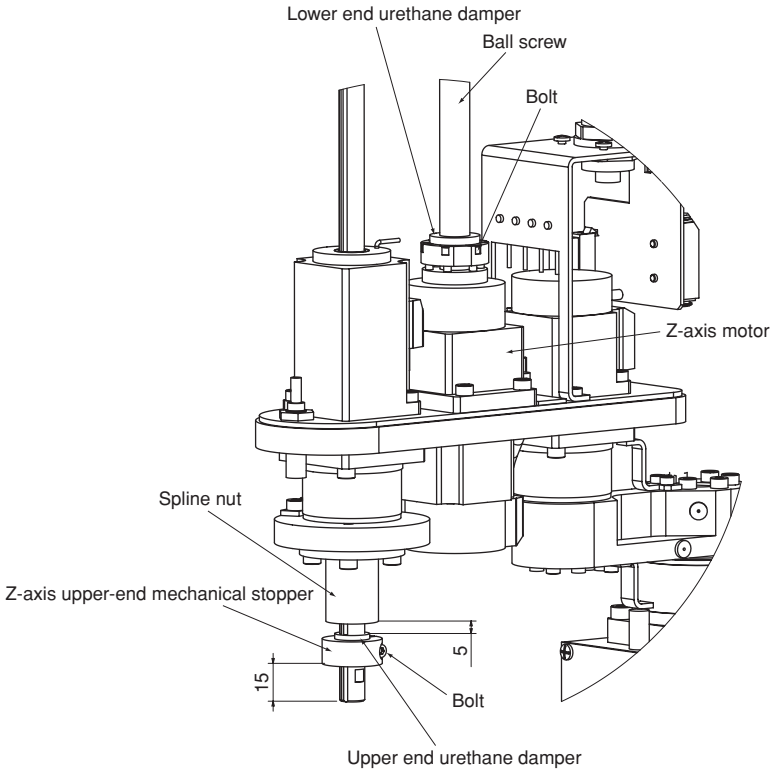

Lower end urethane damper
Ball screw
Bolt
Z-axis motor
Spline nut
Z-axis upper-end mechanical stopper
5
15
Bolt
Upper end urethane damper

Fig. 4-15

4 Setting the Soft Limits

In the YK120X and YK180 series, the working envelope during manual and automatic operation can be limited by setting the plus soft limit [pulses] and minus soft limit [pulses] on each axis.
The origin point (0 [pulses]) is used as the reference to set the soft limits. The working envelope can be limited by specifying the number of pulses from the 0 pulse position. Refer to the "YAMAHA robot controller owner's manual" for further details. Also refer to "1-2 External view and dimensions" in Chapter 7 for the working envelope area.
When performing actual checks of the soft limit settings, operate the robot manually from outside the safeguard enclosure.

(1) Setting the X-axis and Y-axis soft limits

Set the soft limit on the inner side of the movement range limited by the mechanical stopper or on the inner side of the position that interferes with the peripheral devices (note that this must within the maximum working envelope). Set the soft limit with the following procedures.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Press the emergency stop button on the MPB to set emergency stop.
Refer to the "YAMAHA robot controller owner's manual" for further details on emergency stop and canceling emergency stop.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Enter the safeguard enclosure while holding the MPB.

5) Move the X-axis and Y-axis arms by hand to the mechanical stopper positions or to the point where interference with the peripheral equipment occurs, and note the X-axis and Y-axis plus (+) and minus (-) direction pulses displayed on the MPB.

6) Check that no one is inside the safeguard enclosure, then cancel emergency stop from outside the safeguard enclosure.

7) Set the soft limits to within the figure for the X-axis and Y-axis encoder pulses that you noted above in step 5). This software limit setting must be made from outside the safeguard enclosure.
Refer to the "YAMAHA robot controller owner's manual" for further details on soft limit settings.

⚠CAUTION

The origin position adjusted before shipment may vary as shown in "Chapter 7, 1-2 External view and dimensions".
When introducing the robot, be sure to set the soft limits with the number of pulses from the origin position (0 pulse position).

(2) Setting the Z-axis soft limits

Make this setting from outside the safeguard enclosure.

The Z-axis has mechanical stoppers fixed at the upper and lower ends of the Z-axis movement range. When the actual working range of the robot is smaller than the maximum working envelope or the manipulator interferes with the peripheral equipment, reduce the Z-axis plus (+) soft limit [pulses] to narrow the working envelope.

(3) Setting the R-axis soft limit

To make this setting, set emergency stop just as for the X-axis and Y-axis, or be sure to do this from outside the safeguard enclosure. The R-axis has no mechanical stoppers. When the actual working range of the R-axis is small or it interferes with the peripheral equipment, reduce the R axis plus (+) soft limit [pulse] and minus (-) soft limit [pulses] to narrow the working envelope.

⚠CAUTION

Overloads may occur if the soft limit is almost near the encoder pulse at the mechanical stopper and the operating point is used at the edge of the movement range. Set the soft limit to the inner side of the mechanical stopper with an ample safety margin.

(4) Relation between the X, Y and R-axis movement angle, the Z-axis movement distance and the number of pulses

The resolver pulse for X, Y- and R-axes movement angle and the for the Z-axis movement length are shown below. Use these figures as a guide to set the soft limits.

YK120X, YK150X

Axis	Number of resolver pulses per turn (360 degrees)
X, Y	204800
R	122880

Axis	Number of resolver pulses per 12 mm movement of one lead
Z	4096

YK180X, YK220X

Axis	Number of resolver pulses per turn (360 degrees)
X, Y	819200
R	491520

Axis	Number of resolver pulses per 12 mm movement of one lead
Z	16384

5 Setting the Standard Coordinates

⚠CAUTION

If the standard coordinate settings are incorrect, the acceleration cannot be optimized to match the arm position. This results in too short a service life, damage to the drive unit, or residual vibration during positioning. In addition, the cartesian coordinate accuracy will be impaired.

Setting the standard coordinates enables the following operations and functions.

1. Optimizes acceleration according to arm position during automatic op eration.
2. Allows moving robot arm tip at right angles.
3. Allows using shift coordinates.
4. Enables commands such as linear interpolation and arm switching.

The procedure for setting standard coordinates and cautions are shown below.

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.

2) Check that the soft limits are correctly set.
If not correctly set, adjust the soft limits while referring to the description of "4 Setting the Soft Limits" in Chapter 4.

3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller or operation panel.

4) Enter the safeguard enclosure while holding the MPB. Stay outside the robot movement range at this time.

5) Make the standard coordinate settings while referring to methods for "Setting the Standard Coordinates" as explained in the "YAMAHA robot controller owner's manual". Never enter within the robot movement range.

6) When the standard coordinate settings are complete, check the following points from outside the safeguard enclosure.
   1. Check that the robot arm tip can move at right angles in MANUAL operation (cartesian coordinates).
   2. Check that the values nearly equal to the X-axis and Y-axis arm lengths are entered in "Arm length" of the axis parameters.

   If the above points are not satisfied, the standard coordinate settings are incorrect, so make the standard coordinate settings again.

6 Affixing Stickers for Movement Directions and Axis Names

The movement direction and axis name label shown in Fig. 4-16 is supplied with the robot. After installing the peripheral devices, attach these labels at an easy-to-see position on the robot.

1) Turn off the controller.

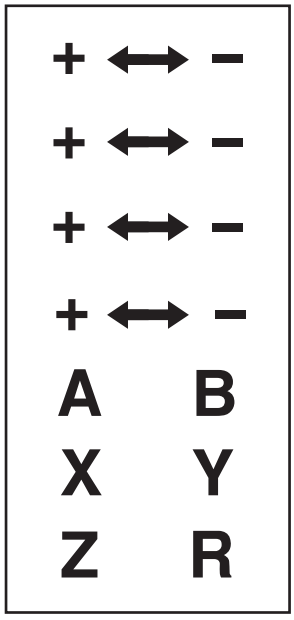
2) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.

3) Enter the safeguard enclosure.

4) Attach the movement direction and axis name labels at an easy-to-see position on the robot arm, base and end effector, etc., of each axis which moves relatively. Wipe the surface with alcohol, etc., and allow to dry completely before attaching the labels. (See Fig. 4-17)

⚠ WARNING

Attach the movement direction label according to the jog movement direction, and the axis name label according to the axis. Incorrect label positions could result in incorrect operations.



Direction of movement and axis name stickers

Fig. 4-16

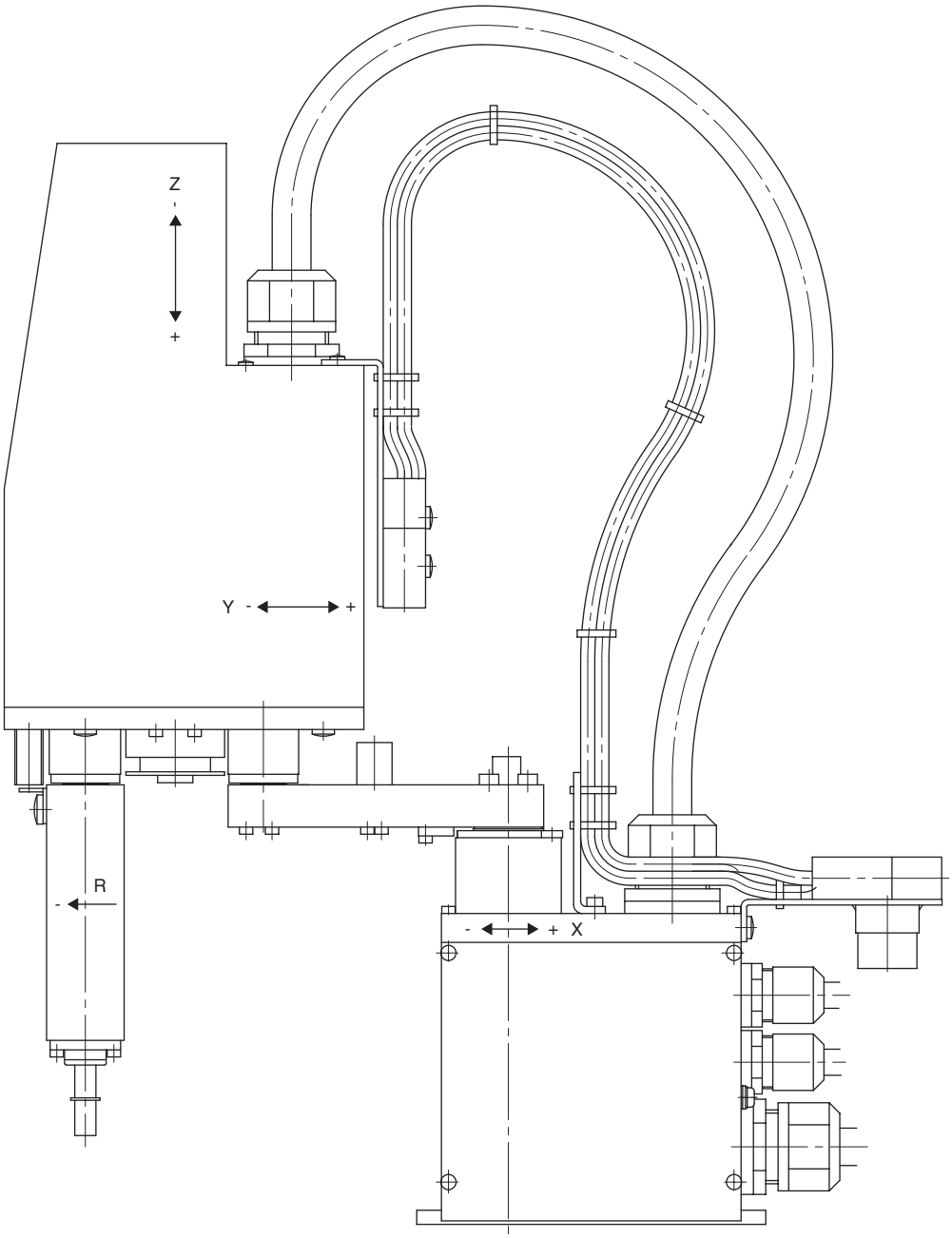


Fig. 4-17 Positions for affixing the stickers

7 Removing the Robot Covers

To remove the robot cover, follow the procedure below.

1) Prepare the necessary tools.
   • Phillips-head screwdriver

2) Turn off the controller.

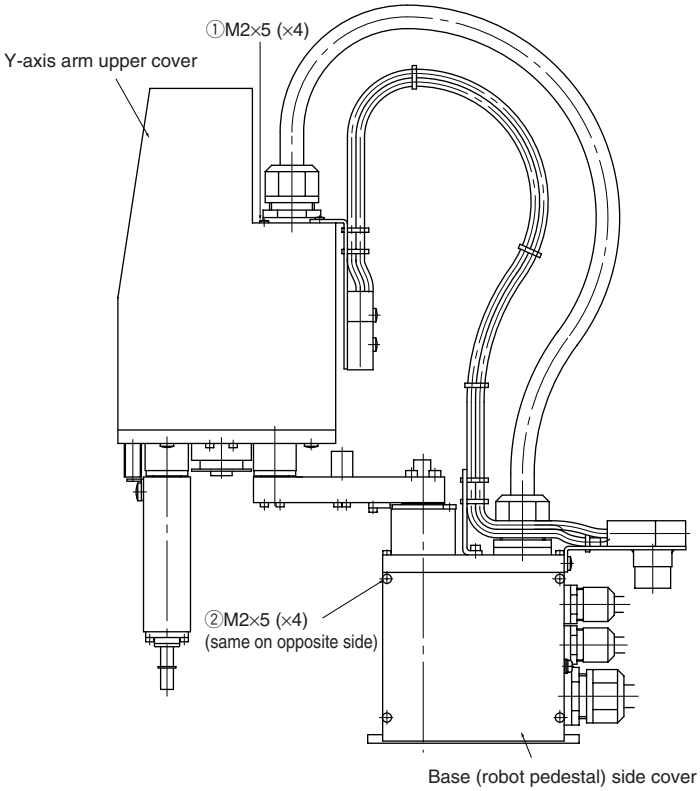
3) Place a sign indicating the robot is being adjusted, to keep others from operating the controller switch.

4) Enter the safeguard enclosure.

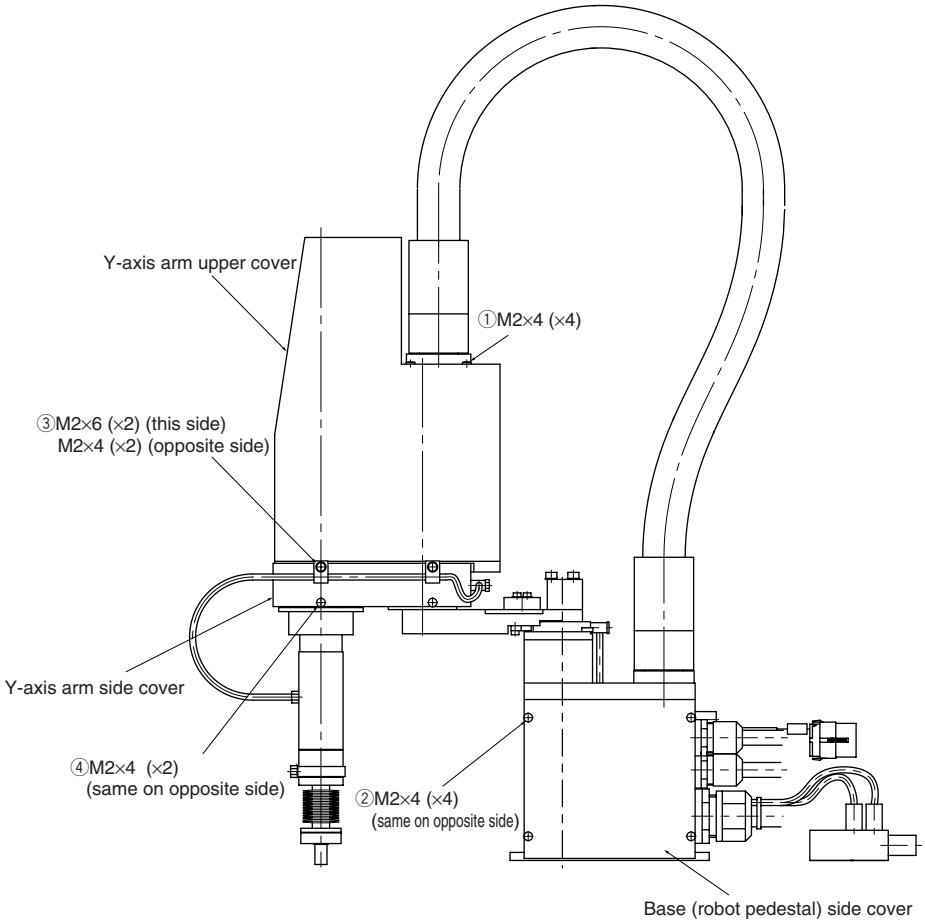
5) Remove the covers while referring to Fig. 4-18, Fig. 4-19.

⚠CAUTION

The Z-axis might be locked depending on how the Y-axis upper cover is reattached. So, after reattaching the cover, release the Z-axis brake while propping the Z-axis with a proper support or stand to check that the Z-axis is not locked.

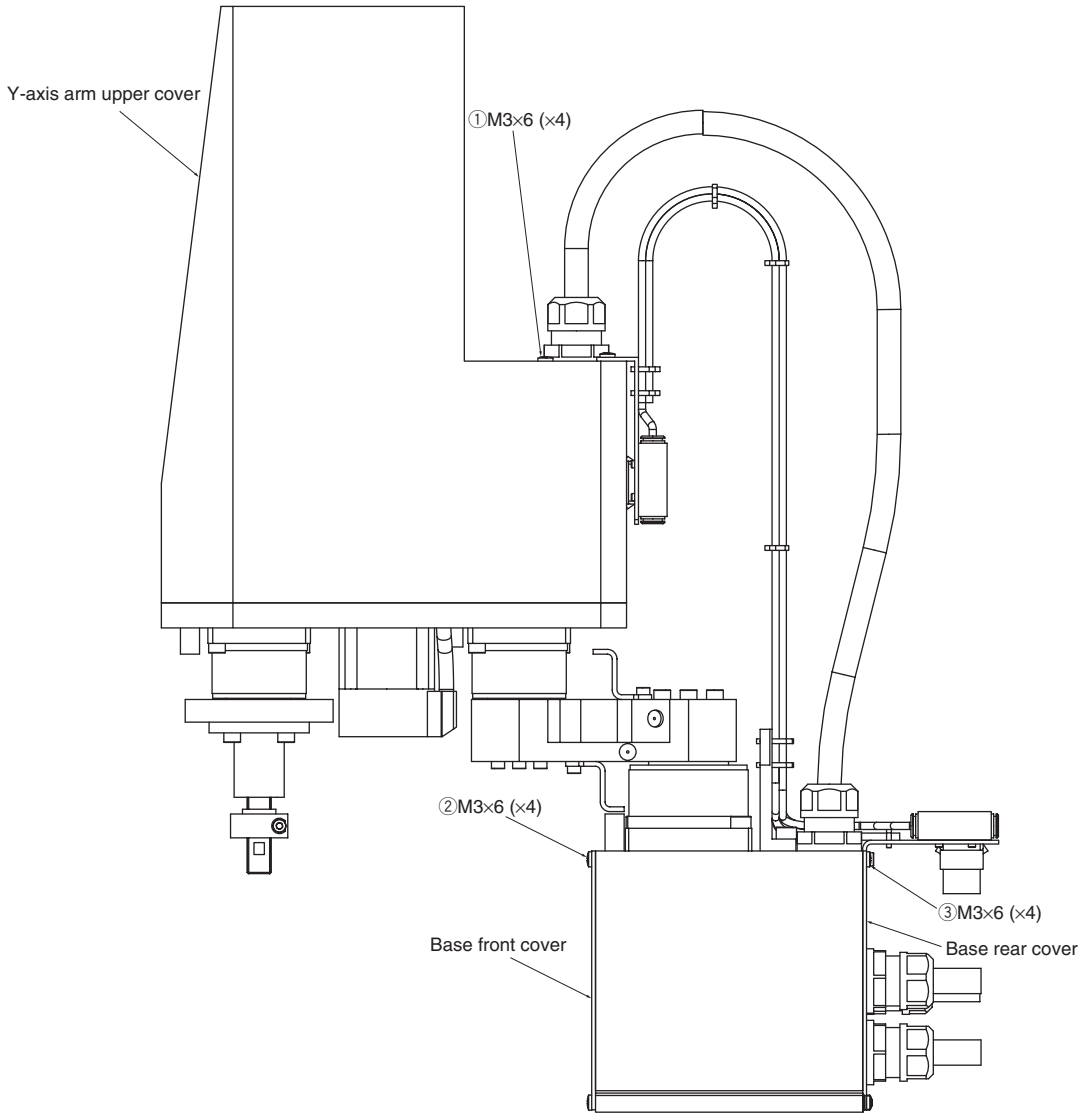


YK120X, YK150X



YK120XC, YK150XC

Fig. 4-18



YK180X, YK220X

Fig. 4-19

MEMO

CHAPTER 5

Periodic Inspecition

MEMO

1 Overview

Daily and periodic inspection of the YAMAHA robot is essential in order to ensure safe and efficient operation. This chapter describes the periodic inspection items and procedures for the YAMAHA YK120X series and YK180 series robots.

Periodic inspection includes:

- Daily inspection
- 6-month inspection
- Replacing the speed reduction gear (harmonic drive) grease

Make sure that you thoroughly understand details of the inspection and follow the procedures and precautions explained in this chapter.

2 Precautions

(1) Periodic inspection must be performed by or in the presence of personnel who have received the Robot Training given by YAMAHA or YAMAHA dealers.

(2) Do not attempt any inspection, adjustment, repair and parts replacement not described in this manual. This work requires specialized technical knowledge and skill, and may also involve work hazards.

(3) When inspection is required inside the safeguard enclosure, always turn off the controller and also the external switch board.

(4) If the inspection or maintenance procedure calls for operation of the robot, stay outside the safeguard enclosure.

(5) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch, programming unit or operation panel.

(6) Use only the lubricants specified by YAMAHA or YAMAHA dealers.

(7) To check the operation after inspection, refer to "6 Trial operation" in Chapter 1.

⚠ WARNING

- When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
- Never touch any internal parts of the controller.

For precautions on handling the controller, refer to the "YAMAHA robot controller owner's manual".

3 Daily Inspection

The following is an inspection list that must be performed every day before and after operating the robot.

(1) Inspection to be performed with the controller turned off

1) Turn off the controller.
2) Place a sign indicating the robot is being inspected, to keep others from operating the controller switch.
3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Machine harness Robot cable User cable and wiring	Check for scratches, dents and excessive bend and kinks. (If the machine harness or robot cable is damaged, contact YAMAHA dealer.)
Regulator, joints, air tube, solenoid valve, air cylinder	Check air pressure. Check for air leaks. Check drain. Check air filter for clogging or damage.
Robot exterior	Check for damage. (If a damage is found, contact YAMAHA dealer.)

(2) Inspection to be performed with the controller turned on

1) Check that no one is inside the safeguard enclosure, and then turn on the controller.
2) Place a sign indicating the robot is being inspected, to keep others from operating the controller, programming unit or operation panel.
3) Check the following points from outside the safeguard enclosure.

Checkpoint	Procedure
Safeguard enclosure	Check if the safeguard enclosure is in place. Check if emergency stop is triggered when the door is opened. Check if warning labels are affixed at the entrance and clearly visible.
Emergency stop device	Press the emergency stop button to check if it works.
Robot movement	Check for abnormal movement and excessive vibration and noise. (If any abnormal symptom is found, contact YAMAHA dealer.)
Z-axis brake operation *1	Check if the brake works to stop the Z-axis from dropping more than 3mm from the stationary point. (If any abnormal operation is found, contact YAMAHA dealer.)

*1 Visually check the Z-axis movement when you press the emergency stop button from outside the safeguard enclosure and also when you turn off the controller.

(3) Adjustment and parts replacement

1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

4 Six-Month Inspection

Take the following precautions when performing 6-month inspection.

⚠ WARNING

Injury can occur if hands or fingers are squeezed between the drive pulley and belt. Always turn off the controller and use caution when handling these parts.

⚠ WARNING

The Z-axis will slide down when the Z-axis brake is released, causing a hazardous situation. Do not release the brake when lubricating the Z-axis parts.

When lubricating the ball screw, spline shaft and linear busing shaft, observe the following precautions.

⚠ WARNING

Precautions when handling grease:
- Inflammation may occur if this gets in the eyes.
  Before handling the grease, wear your safety goggles to ensure the grease will not come in contact with the eyes.
- Inflammation may occur if the grease comes into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat the grease or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:
- If this grease gets in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If this grease comes in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

⚠ WARNING

Disposing of grease and the container:
- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

⚠ CAUTION

Unless grease specified by YAMAHA is used, the service life of the ball screw, ball spline and linear bushing shaft will shorten.

(1) Inspection to be performed with the controller turned off

1) Turn off the controller.

2) Place a sign showing that the robot is being inspected, to keep others from operating the controller switch.

3) Enter the safeguard enclosure and check the following points.

Checkpoint	Procedure
Manipulator bolts and screws (Only for major bolts and screws exposed externally)	Check for looseness and tighten if necessary.*1
Detection areas of the origin sensors of the R-axis	Clean if it is dirty.
Controller	Check for looseness at each terminal and connector on the panel. (See 4 in Chapter 3.)
Grease lubrication of Z-axis ball screw, spline, linear shaft	After removing the old grease with a cloth or paper towel, apply new grease to the Z-axis linear bushing shaft, spline shaft, ball screw shaft and ball screw nut. Recommended grease: YK120K, YK150X, YK180X, YK220X: Alvania No.2 (Showa Shell Sekiyu K.K.) YK120XC, YK150XC: LG2 (NSK) Always use the LG2 grease for the YK120XC and YX150XC clean room models.
Z-axis ball spline, ball screw	Check for backlash. (If any abnormality is found, contact YAMAHA dealer.)

*1 Bolt tightening torque

Bolt size	Tightening torque (kgfcm)	Tightening torque (Nm)
M3 button head bolt	14	1.4
M3 set screw	7	0.69
M4 set screw	20	2.0
M2 bolt installation hole	4.4	0.43
M2.5 bolt installation hole	12	1.2
M3 bolt installation hole	20	2.0
M4 bolt installation hole	46	4.5
M5 bolt installation hole	92	9.0
M6 bolt installation hole	156	15.3
M8 bolt installation hole	380	37
M10 bolt installation hole	720	71
M12 bolt installation hole	1310	128
M14 bolt installation hole	2090	205

(2) Inspection to be performed with the controller turned on

⚠ WARNING

The robot controller must be installed outside the safeguard enclosure, to prevent a hazardous situation in which you or anyone enter the safeguard enclosure to inspect the controller while it is turned on.

⚠ WARNING

- Bodily injury may occur from coming into contact with the fan while it is rotating.
- When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.

After turning on the controller, check the following points.

Checkpoint	Procedure
• Cooling fan at rear of controller	• Check if the fan rotates normally. • Check if objects blocking the fan are located and remove if any are found. • Check for abnormal noise from the rotating fan. If abnormal noise is heard, visually check and remove the cause. If no cause is found, contact YAMAHA dealer. • Check for dust on the fan cover. Remove and clean if necessary.

(3) Adjustment and parts replacement

1) After inspection, if you notice any adjustment or parts replacement is needed, first turn off the controller and then enter the safeguard enclosure to perform the necessary work. After adjustment or replacement is finished, again review the checkpoints outlined in (1) and (2) above.

2) If repair or parts replacement is required for the robot or controller, please contact your YAMAHA dealer. This work requires specialized technical knowledge and skill, so do not attempt it by yourself.

5 Replacing the Harmonic Drive Grease

The YK120X series and YK180X series robots use a harmonic drive as the speed reduction gear for the X-axis, Y-axis and R-axis. The harmonic drive grease (SK-2) must be replaced periodically. Determine the harmonic grease replacement period with the following procedures.
Each axis must be disassembled when replacing the harmonic drive grease, so contact YAMAHA for servicing.

5-1 Replacement period

The harmonic drive replacement period is determined by the total number of turns of the wave generator used in the harmonic drive. A calculation example is shown below. It is recommended to replace the harmonic drive when the total number of turns has reached 1.5×10^8 (at ambient operating temperatures of 0°C to +40°C). This means that the replacement period will differ depending on the following operating conditions. If the robot operation duty ratio is high or the robot is operated in environments at higher temperatures, the harmonic drive should be replaced earlier.

Replacement period = $1.5\times10^8/(n\times60\times h\times D\times N\times\theta)$ years

where
- n : Number of axis movements per minute
- θ : Average turn per axis movement
- N : Speed reduction ratio
- h : Operation time per day
- D : Operation days per year

For θ, a 90° axis rotation is a one-quarter rotation.

Example) Harmonic drive replacement period when axis rotates an average of one-quarter with each movement, and moves 10 times in one minute. (Operation time: 24 hours/day, No. of operation days: 240 days/year)

- n : 10
- θ : 0.25
- N : 50
- h : 24 hours per day
- D : 240 days per year

Replacement period = $1.5\times10^8/(n\times60\times h\times D\times N\times\theta)$
= $1.5\times10^8/(10\times60\times24\times240\times50\times0.25)$
= 3.5 years

Table 5-1 Harmonic drive speed reduction ratio

X-axis	Y-axis	R-axis
50	50	30

⚠ WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before touching these parts, turn off the controller, wait for a while and check that the temperature has cooled.

⚠ WARNING

Precautions when handling harmonic grease, cleaning oil:

- Inflammation may occur if they get in the eyes.
  Before handling them, wear your safety goggles to ensure they will not come in contact with the eyes.
- Inflammation may occur if they come into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- Hands and fingers might be cut when opening the container, so use protective gloves.
- Keep out of the reach of children.
- Do not heat them or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- If they get in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- If they come in contact with the skin, wash away completely with soap and water.
- If taken internally, do not induce vomiting but promptly consult a physician for treatment.

⚠ WARNING

Disposing of harmonic grease, cleaning oil and the container:

- Proper disposal is compulsory under federal, state and local regulations. Take appropriate measures in compliance with legal regulations.
- Do not pressurize the empty container. Pressurizing may cause the container to rupture.
- Do not attempt to weld, heat up, drill holes or cut this container. This might cause the container to explode and the remaining materials inside it to ignite.

⚠ WARNING

When removing the wave generator from the motor shaft or reinstalling it back onto the motor shaft, use caution to avoid as much as possible, applying a thrust load to the motor shaft. If a load is applied, the resolver may be damaged resulting in a hazardous situation of the robot trouble.

⚠CAUTION

The harmonic drive service life may shorten if the grease recommended by YAMAHA is not used.

Recommended grease

Use the following harmonic drive grease.
SK-2 (made by Harmonic Drive Systems Inc.)

⚠CAUTION

Harmonic drive

- Do not apply strong shocks or impacts to these parts such as with a hammer. Also, do not scratch, scar or dent these parts by dropping, etc. Such actions will damage the harmonic drive.
- The specified performance cannot be maintained if any part of the harmonic drive is used in a damaged state. This damage or wear may also lead to trouble with the harmonic drive.

⚠CAUTION

Since a positional shift occurs after replacing the harmonic drive, it is necessary to make absolute reset, standard coordinate setting and point data setting again.

CHAPTER 6

Increasing the robot operating speed

MEMO

1 Increasing the robot operating speed

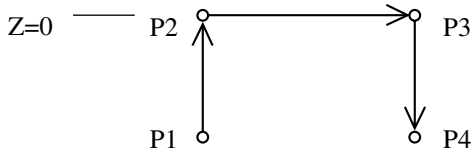
The robot operating speed can be increased by the following methods.
Use these methods as needed when programming.

(1) Increasing speed by arch motion

[Also refer to:] Robot controller owner's manual
("Axis parameters" – "Arch position" in Chapter 4)
Programming manual
(ARCH statement in "11. Command statements".)

① **Gate motion**

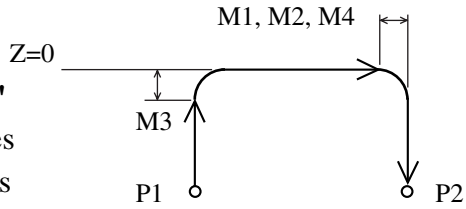
From point P1 to P4 via P2 and P3:
MOVE P, P2
MOVE P, P3
MOVE P, P 4



② **Arch motion: Using default arch position: (2000 pulses)**

From point P1 to P2:
MOVE P, P2, Z=0

"Axis parameters" – "Arch position"
M1 (X-axis arch position) = 2000 pulses
M2 (Y-axis arch position) = 2000 pulses
M3 (Z-axis arch position) = 2000 pulses
M4 (R-axis arch position) = 2000 pulses



When the Z-axis moves upward from P1 and enters the M3 arch position range (2000 pulses prior to Z=0), the X, Y and R axes begin to move. When these 3 axes enter the M1, M2 and M4 arch position range (2000 pulses prior to P2), the Z-axis moves downward to P2. Compared with the gate motion ①, this arch motion shortens the cycle time approximately 20% by moving the robot arm along an arc.

③ Arch motion: Making the arch position value larger

In the arch motion ②, making the arch position value larger can further shorten the cycle time. Since the robot arm moves along a larger arc, use caution to avoid obstacles if they are located near the arm movement path.
The arch position parameter can be set for each axis.

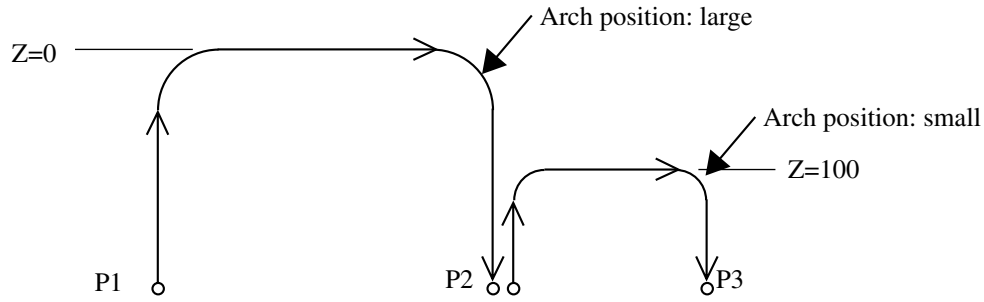
④ Arch motion: changing the arch positions in the program

From point P1 to P2 and then to P3:
ARCH (1) = 10000 ... X-axis arch position (pulses)
ARCH (2) = 20000 ... Y-axis arch position (pulses)
ARCH (3) = 20000 ... Z-axis arch position (pulses)
ARCH (4) = 20000 ... R-axis arch position (pulses)
MOVE P, P2, Z=0
ARCH (1) = 2000
ARCH (2) = 2000
ARCH (3) = 2000
ARCH (4) = 2000
MOVE P, P3, Z=100

Arch position can be set for each axis.

If the same arch position value (pulses) is used for all axes, you can write as "ARCH 2000".

Since the arch positions can be changed in the program, optimizing the arch positions can further shorten the cycle time.

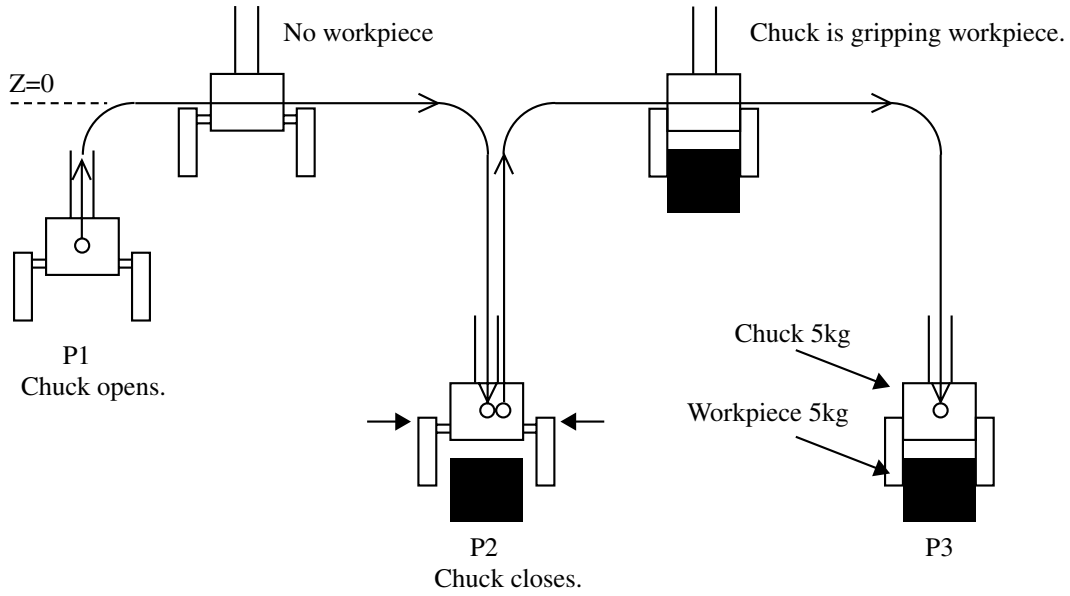


(2) Increasing the speed with the WEIGHT statement

[Also refer to:] Robot controller owner's manual
("Robot parameters" – "Axis tip weight" in Chapter 4)
Programming manual
(WEIGHT statement in "11. Command statements".)

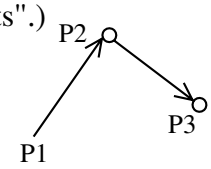
[Example]
From P1 when chuck is open:
WEIGHT 5 .....Changes the axis tip weight parameter to 5kg (no workpiece).
MOVE P, P2, Z=0
DO3 (0) = 1 .....Chuck closes.
WEIGHT 10 .....Changes the axis tip weight parameter to 10kg (with workpiece).
MOVE P, P3, Z=0

In the above program, the acceleration can be set to a higher level by reducing the axis tip weight parameter to 5kg while the chuck does not grip any workpiece, and then set to a lower level by changing the axis tip weight parameter to 10kg. Compared to programs using an axis tip weight parameter left set at 10kg, this method shortens the cycle time since the acceleration is increased.



(3) Increasing the speed by the tolerance parameter

[Also refer to:] Robot controller owner's manual
("Axis parameters" – "Tolerance" in Chapter 4)
Programming manual
(TOLE statement in "11. Command statements".)



[Example]
From P1 to P3 via P2
TOLE (1) = 2048 ... X-axis tolerance (pulses) : Increases the tolerance.
TOLE (2) = 2048 ... Y-axis tolerance (pulses)
TOLE (3) = 2048 ... Z-axis tolerance (pulses)
TOLE (4) = 2048 ... R-axis tolerance (pulses)

Tolerance can be set for each axis. If the same tolerance is used for all axes, you can write as "TOLE 2048".

MOVE P, P2
TOLE (1) = 80 ..... Returns the tolerance to the default value.
TOLE (2) = 80
TOLE (3) = 80
TOLE (4) = 80

If the same tolerance is used for all axes, you can write as "TOLE 80".

MOVE, P, P3

When P2 is an escape point and does not need to be accurately positioned, setting the tolerance parameter to a larger value allows the robot arm to pass through P2 quickly. The larger the tolerance value for the positioning time, the shorter the cycle time will be.
The maximum value of the tolerance parameter is 2048 (pulses) and the default is 80 (pulses).

(4) Increasing the speed by the OUT effective position parameter

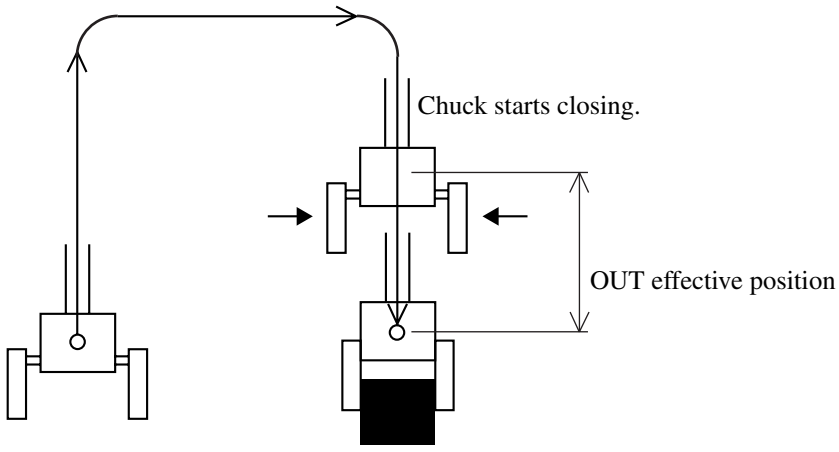
[Also refer to:] Robot controller owner's manual
("Axis parameters" – "Out effective Position" in Chapter 4)
Programming manual
(OUTPOS statement in "11. Command statements".)

[Example]
From P1 when chuck is open:
OUTPOS (1) = 10000 ... X-axis OUT effective position (pulses) : Increases the OUT effective position.
OUTPOS (2) = 10000 ... Y-axis OUT effective position (pulses)
OUTPOS (3) = 10000 ... Z-axis OUT effective position (pulses)
OUTPOS (4) = 10000 ... R-axis OUT effective position (pulses)

The OUT effective position can be set for each axis.
If the same OUT effective position is used for all axes, you can write as "OUTPOS 10000".

MOVE P, P2, Z=0
DO3 (0) = 1 ..... Chuck closes.
OUTPOS (1) = 2000 ..... Returns the OUT effective position to the default value.
OUTPOS (2) = 2000
OUTPOS (3) = 2000
OUTPOS (4) = 2000

If the same OUT effective position is used for all axes, you can write as "OUTPOS 2000".



When all of the X, Y, Z and R axes enter the OUT effective position (10000 pulses prior to P2), the chuck starts closing.
By setting the OUT effective position larger, the chuck starts closing while the robot arm is still moving at an earlier point, so that the chuck can grip the workpiece more quickly.
The default value of the OUT effective position is 2000 (pulses).

[Reference]
Relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values
The arch position, tolerance and OUT effective position parameters are set in pulses.
For the relation between X, Y, R-axis rotating angle, Z-axis movement distance and pulse values, refer to the tables listed under item (4) in "4. Setting the soft limits". (Chapter 4 in this manual)

MEMO

CHAPTER 7

Specifications

MEMO

1 Manipulator

1-1 Basic specification

Robot model			YK120X	YK150X	YK120XC	YK150XC	YK180X	YK220X
Axis specifications	X-axis	Arm length	69.5mm	99.5mm	69.5mm	99.5mm	71mm	111mm
		Rotation angle	±113°	±113°	±113°	±113°	±120°	±120°
	Y-axis	Arm length	50.5mm	50.5mm	50.5mm	50.5mm	109mm	109mm
		Rotation angle	±139°	±139°	±139°	±139°	±140°	±140°
	Z-axis	Stroke	30mm	30mm	30mm	30mm	100mm	100mm
	R-axis	Rotation angle	±360°	±360°	±360°	±360°	±360°	±360°
Motor		X-axis	15W	15W	15W	15W	50W	50W
		Y-axis	13W	13W	13W	13W	30W	30W
		Z-axis	13W	13W	13W	13W	30W	30W
		R-axis	13W	13W	13W	13W	30W	30W
Maximum speed		XY resultant	1.8m/s	2.1m/s	1.8m/s	2.1m/s	3.3m/s	3.4m/s
		Z-axis	0.7m/s	0.7m/s	0.5m/s	0.5m/s	0.7m/s	0.7m/s
		R-axis	1700°/s	1700°/s	1700°/s	1700°/s	1700°/s	1700°/s
Repeatability *1		XY-axes	±0.005mm	±0.005mm	±0.01mm	±0.01mm	±0.01mm	±0.01mm
		Z-axis	±0.01mm	±0.01mm	±0.01mm	±0.01mm	±0.01mm	±0.01mm
		R-axis	±0.006°	±0.006°	±0.006°	±0.006°	±0.01°	±0.01°
Payload			0.5kg				1.0kg	
R-axis tolerable moment of inertia *2			0.002kgm² (0.02kgfcms²)				0.0098kgm² (0.1kgfcms²)	
User wiring			6 cables					
User tubing			φ3×2					
Travel limit			1.Soft limit 2.Mechanical limit (XYZ-axes)					
Robot cable			3.5m (option: 5m, 10m)					
Weight			3kg	3.1kg	3kg	3.1kg	7kg	
Degree of cleanliness			–		Class 10 (0.1μm level during suction)		–	
Suction amount			–		25Nℓ/min		–	

*1 At constant ambient temperature, measured when the robot arm was moved 7 times in the same direction.
Repeatable positioning accuracy = $\pm \frac{|\text{Maximum value} - \text{Minimum value}|}{2}$

*2 There are limits to acceleration coefficient settings.

1-2 External view and dimensions

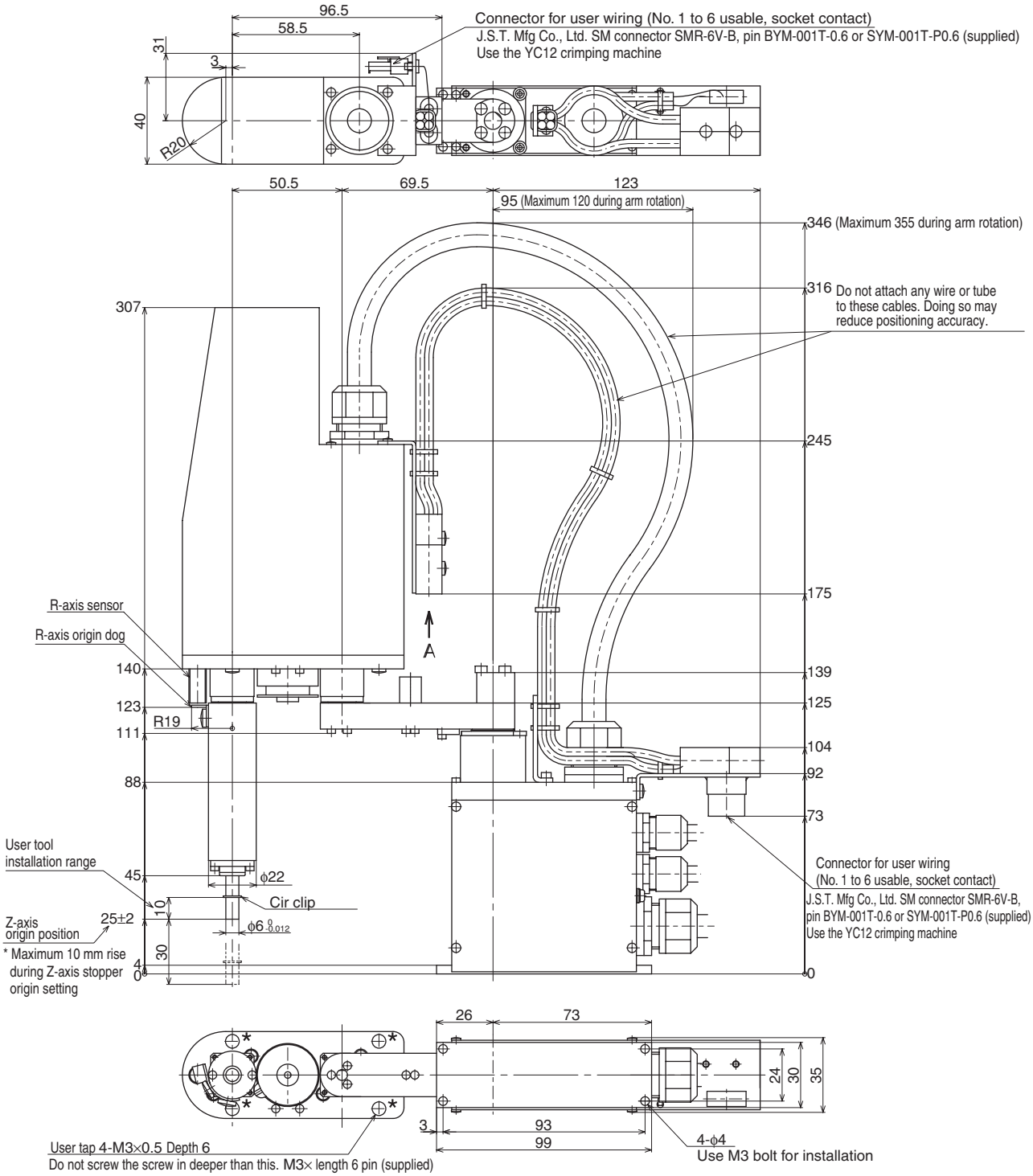
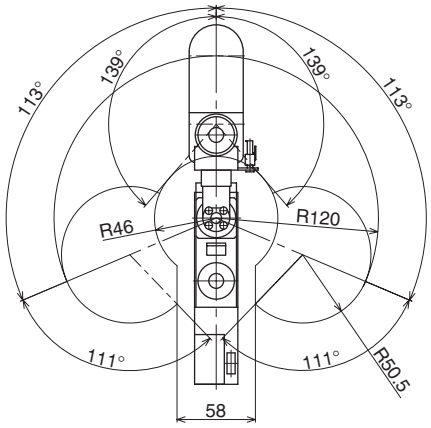
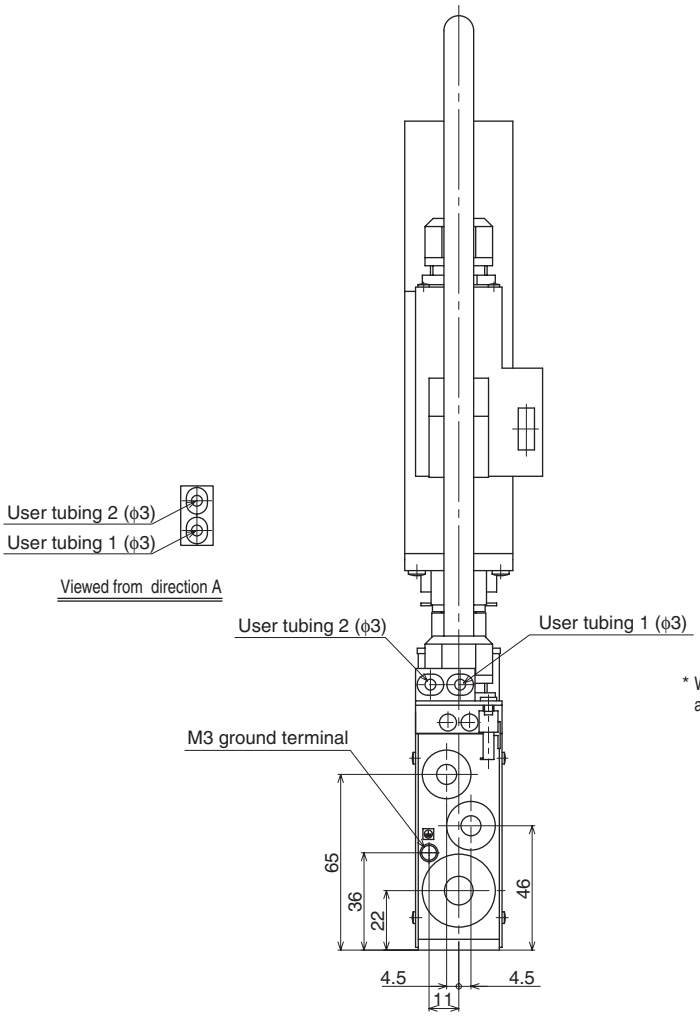
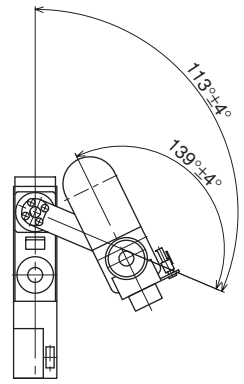


Fig. 7-1 YK120X



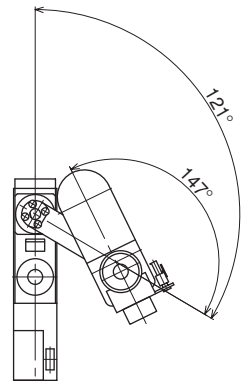
Working envelope





X, Y-axis origin position

* When carrying out X, Y-axis absolute reset stopper origin setting, move the X-axis to a position counterclockwise from this position and the Y-axis to a position clockwise.



X, Y-axis maximum movement position during X, Y-axis absolute reset stopper origin setting

* Take care to prevent interference between the end tool, robot and peripheral devices, etc.

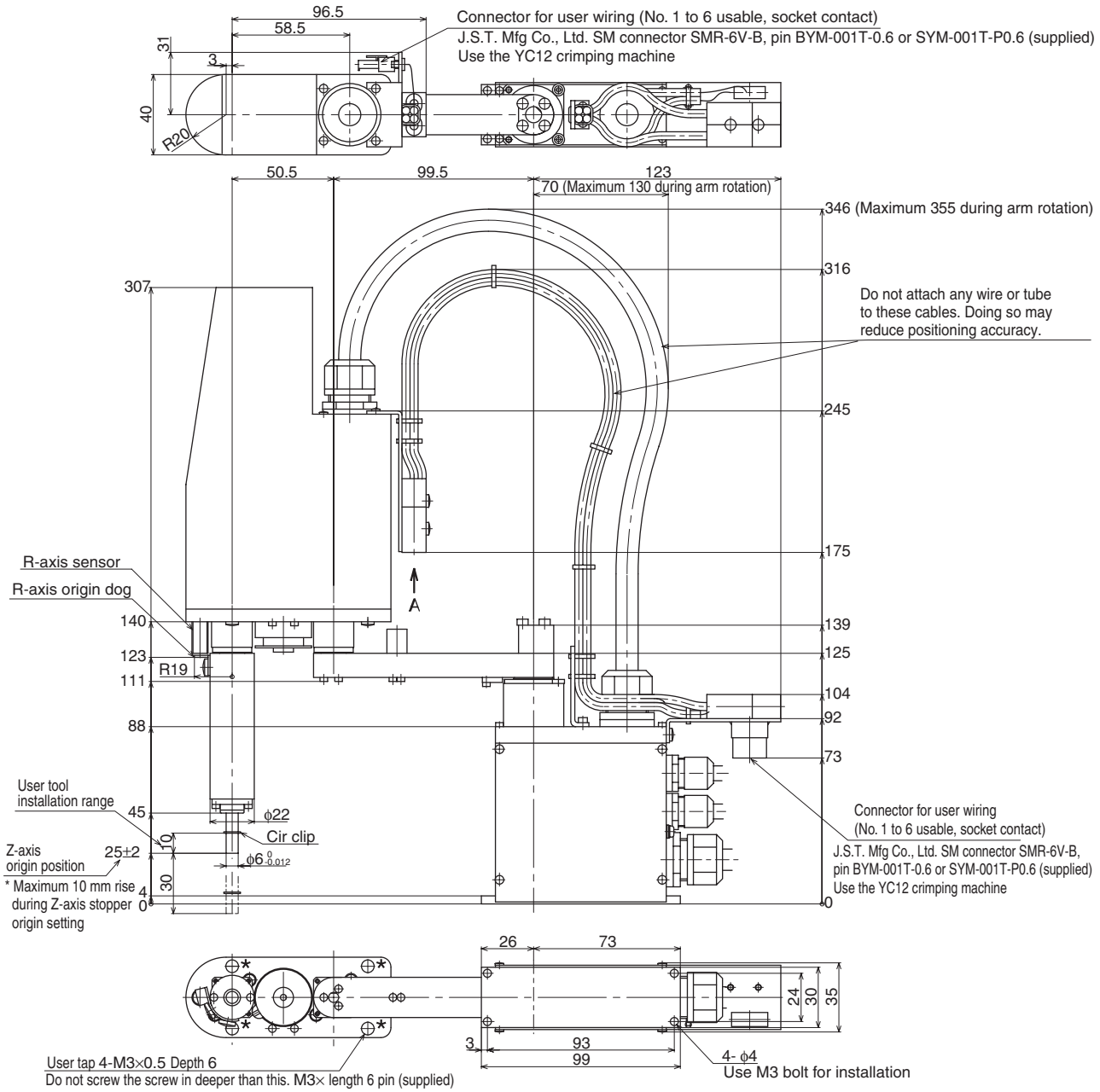
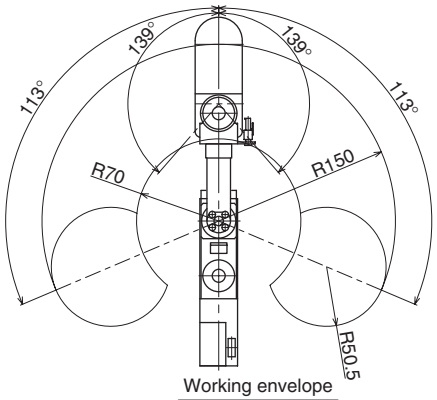
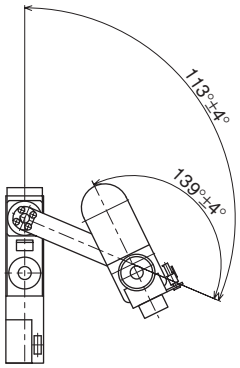


Fig. 7-2 YK150X

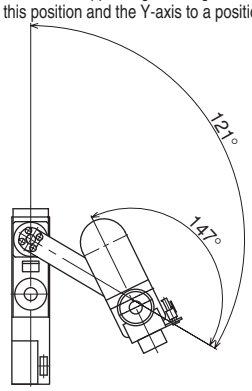


Working envelope



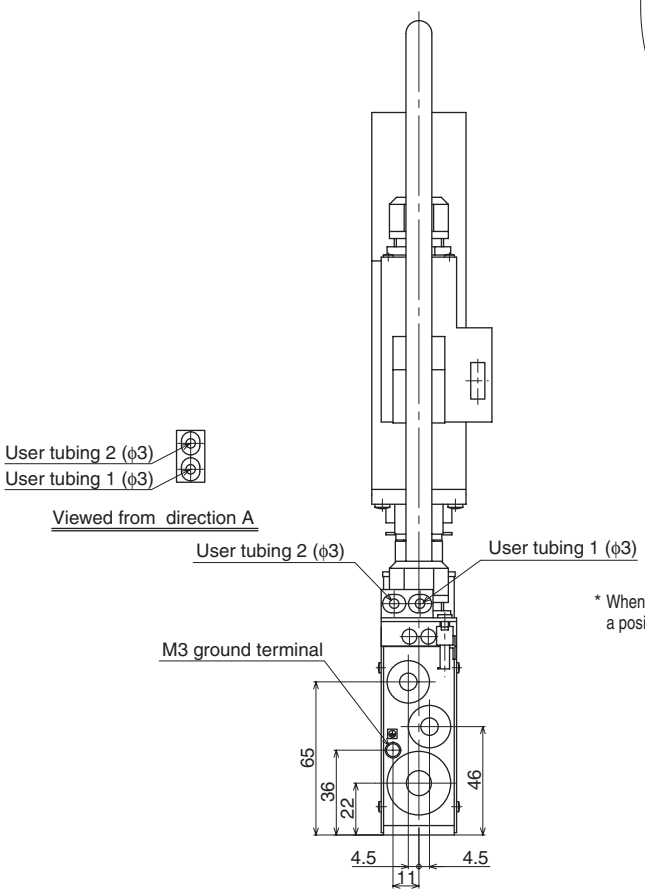
X, Y-axis origin position

* When carrying out X, Y-axis absolute reset stopper origin setting, move the X-axis to a position counterclockwise from this position and the Y-axis to a position clockwise.



X, Y-axis maximum movement position during X, Y-axis absolute reset stopper origin setting

* Take care to prevent interference between the end tool, robot and peripheral devices, etc.



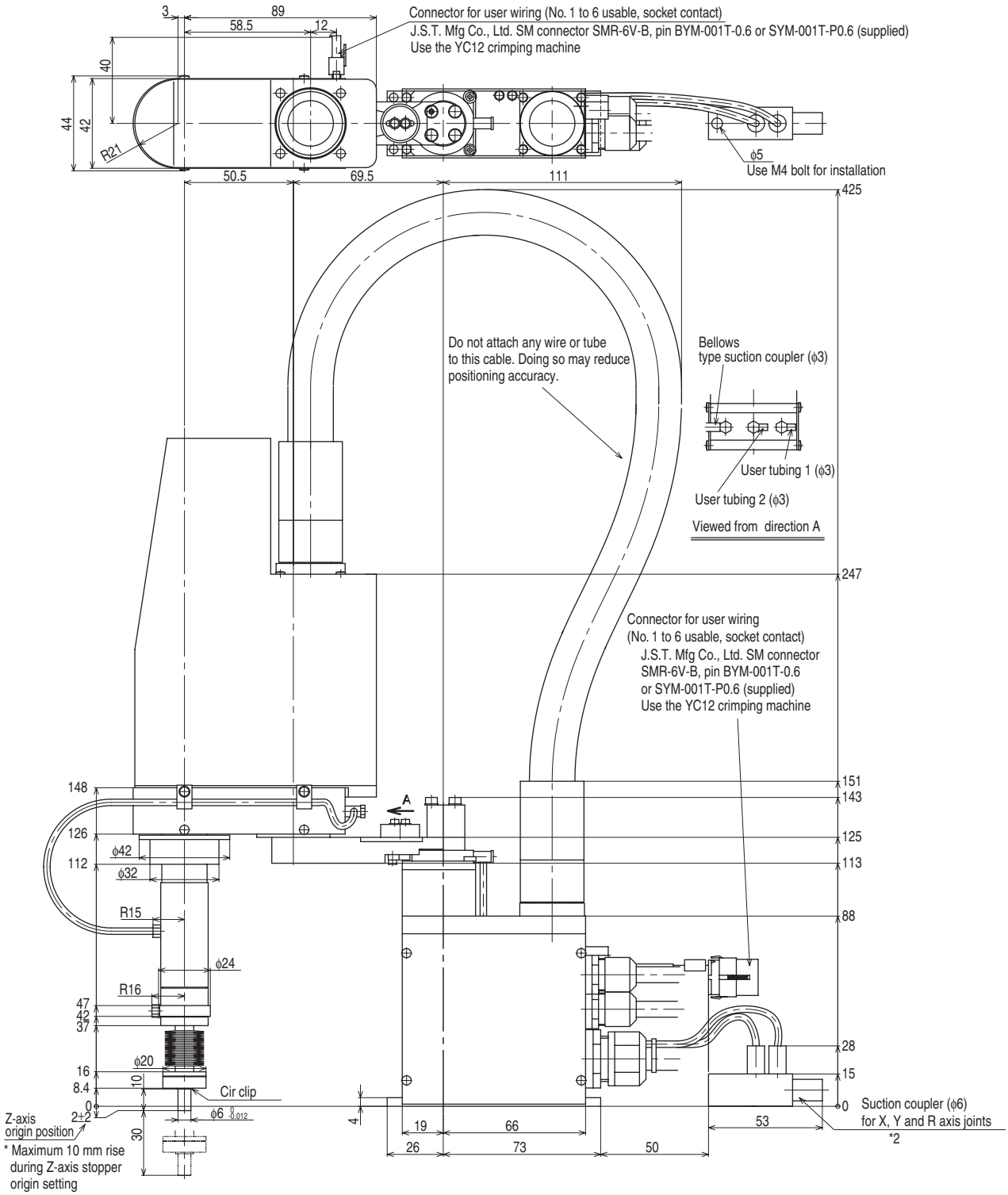
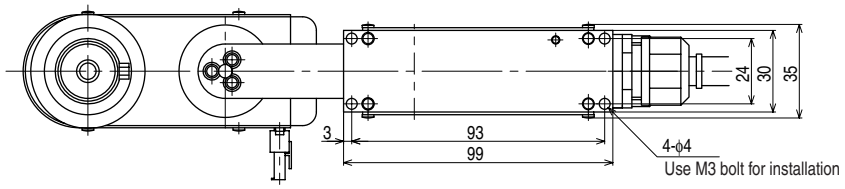
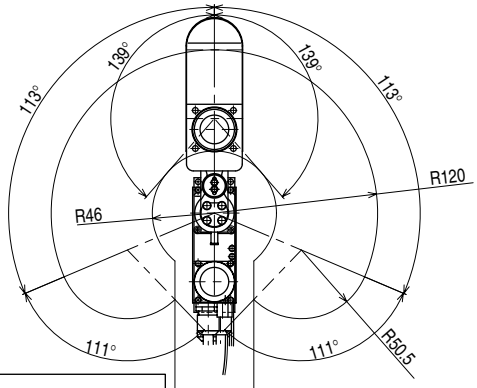
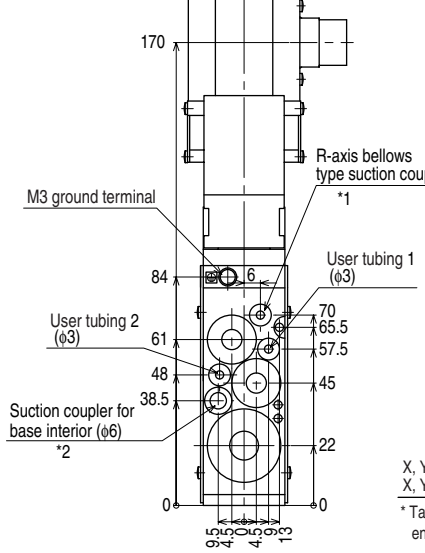


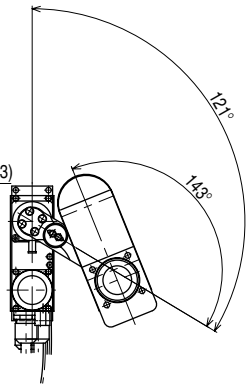
Fig. 7-3 YK120XC





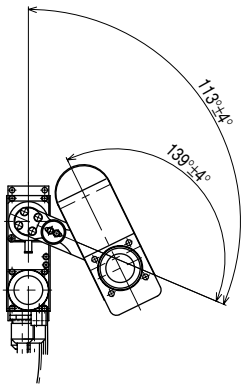
NOTE
1. Suction amount for suction coupler *1 : 25 Nl/min
   Suction amount lower than this level cannot maintain the degree of cleanliness and higher than this level may damage the Z-axis bellows.
2. Suction amount for suction couplers *2 : 25 Nl/min (Simultaneous suction through two φ6 couplers is possible.)
   Suction amount lower than this level cannot maintain the degree of cleanliness.
3. Always set the maximum Z-axis rotating speed (axis parameter No. 37) to "1500". If higher than this value, the degree of cleanliness cannot be maintained and the bellows might be damaged.





X, Y-axis maximum movement position during
X, Y-axis absolute reset stopper origin setting

* Take care to prevent interference between the end tool, robot and peripheral devices, etc.



X, Y-axis origin position

* When carrying out X, Y-axis absolute reset stopper origin setting, move the X-axis to a position counterclockwise from this position and the Y-axis to a position clockwise.

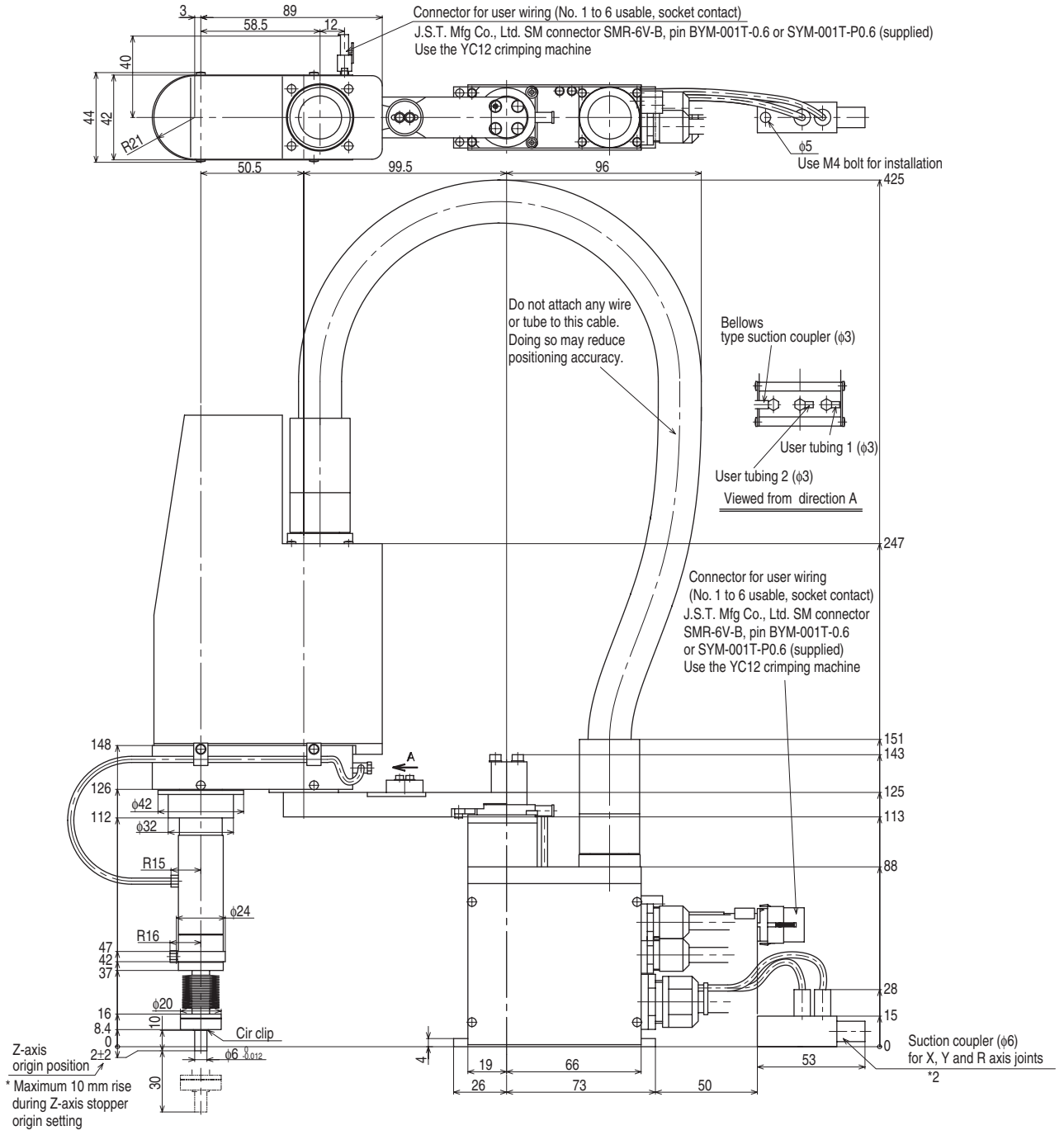
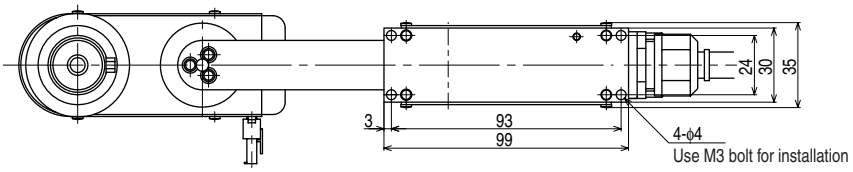
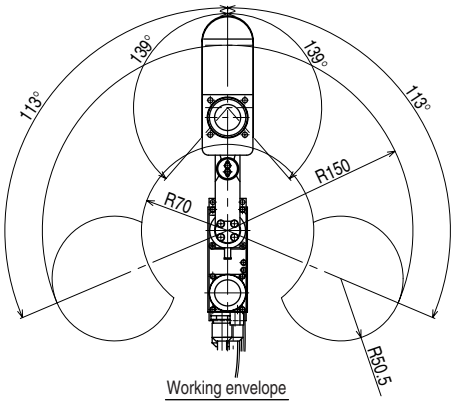
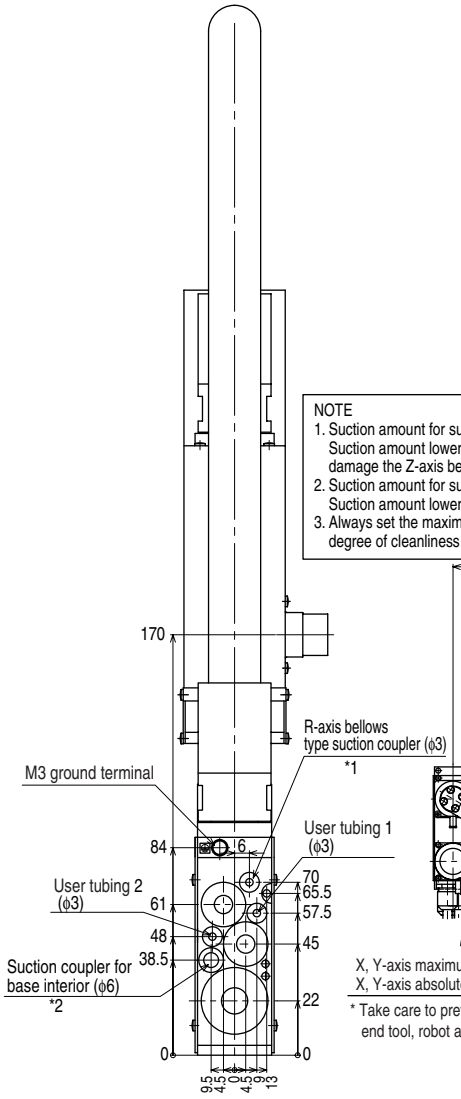


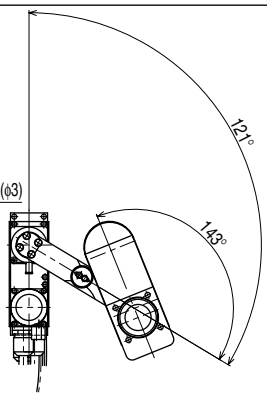
Fig. 7-4 YK150XC





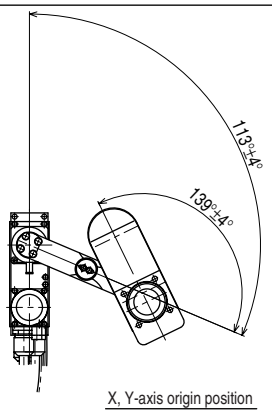
NOTE
1. Suction amount for suction coupler *1 : 25 Nl/min
   Suction amount lower than this level cannot maintain the degree of cleanliness and higher than this level may damage the Z-axis bellows.
2. Suction amount for suction couplers *2 : 25 Nl/min (Simultaneous suction through two φ6 couplers is possible.)
   Suction amount lower than this level cannot maintain the degree of cleanliness.
3. Always set the maximum Z-axis rotating speed (axis parameter No. 37) to "1500". If higher than this value, the degree of cleanliness cannot be maintained and the bellows might be damaged.





X, Y-axis maximum movement position during
X, Y-axis absolute reset stopper origin setting

* Take care to prevent interference between the end tool, robot and peripheral devices, etc.



X, Y-axis origin position

* When carrying out X, Y-axis absolute reset stopper origin setting, move the X-axis to a position counterclockwise from this position and the Y-axis to a position clockwise.

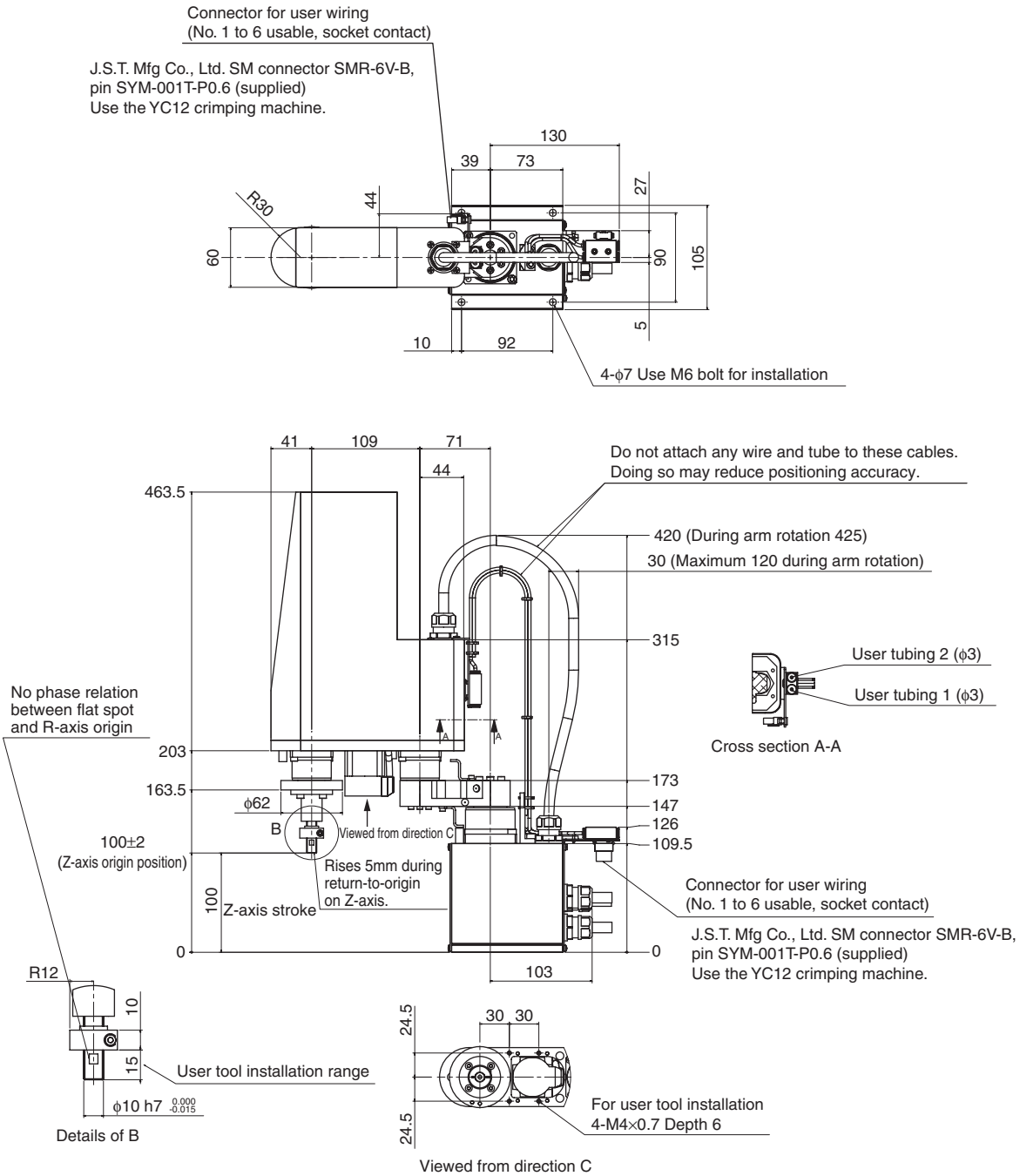
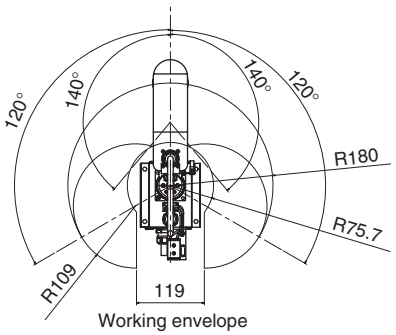
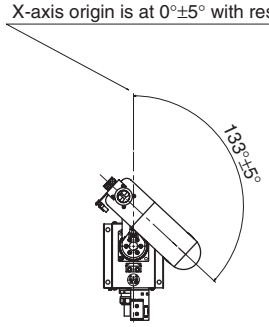


Fig. 7-5 YK180X



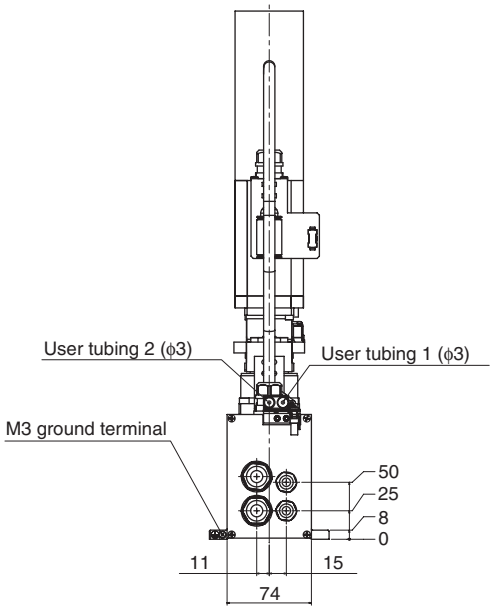
Working envelope

X-axis origin is at 0°±5° with respect to front of robot base



X, Y-axis origin position

When performing return-to-origin, move the axes counterclockwise in advance from the position shown above.



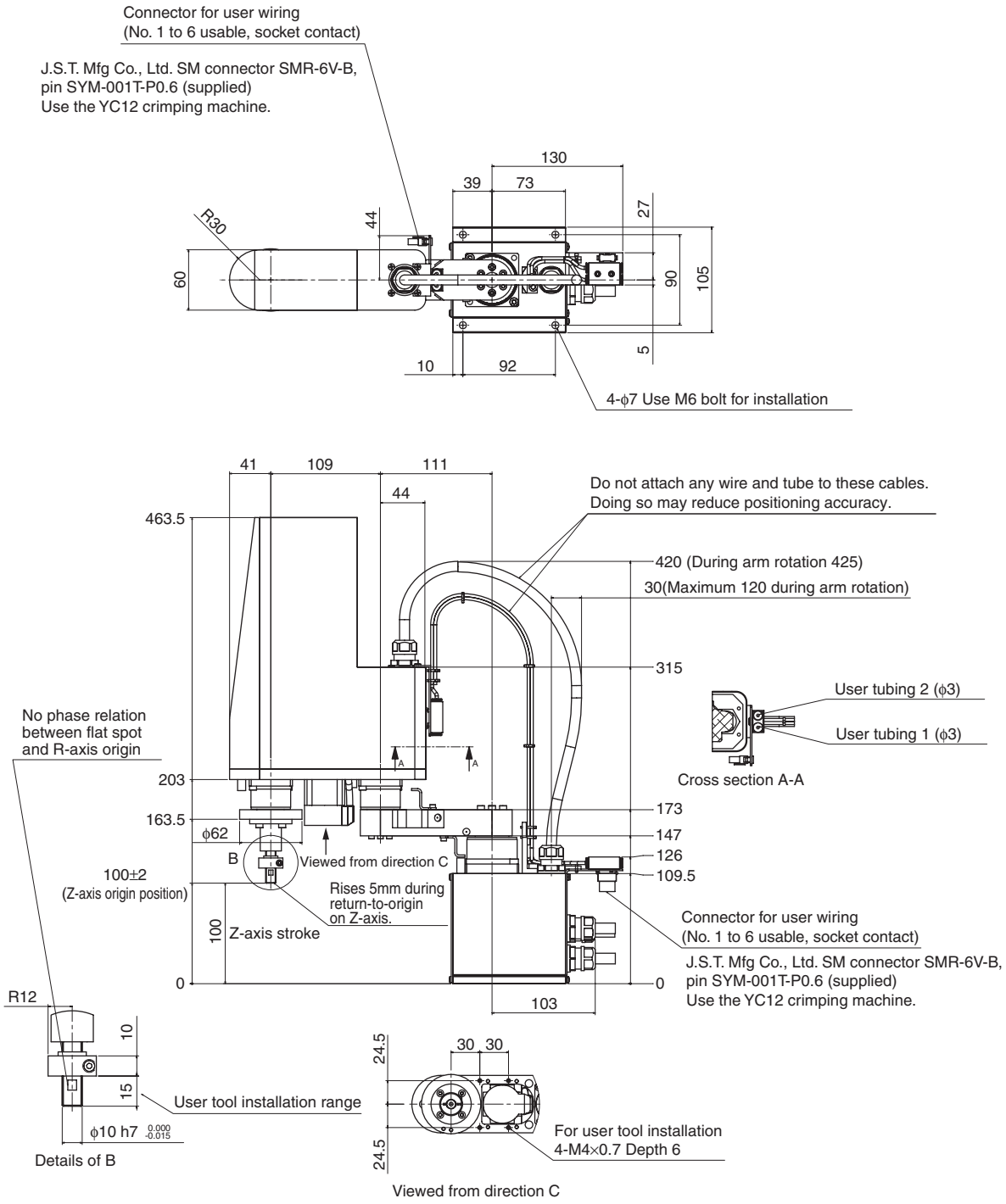
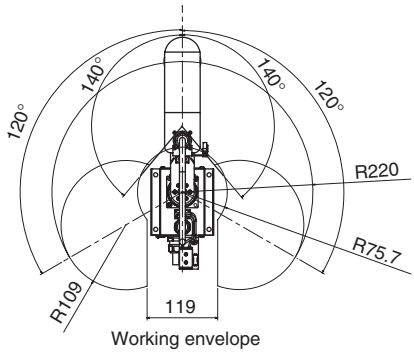
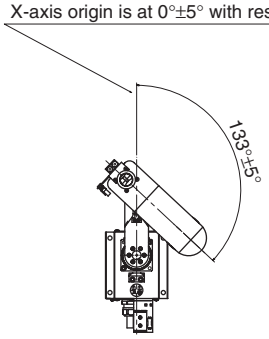


Fig. 7-6 YK220X



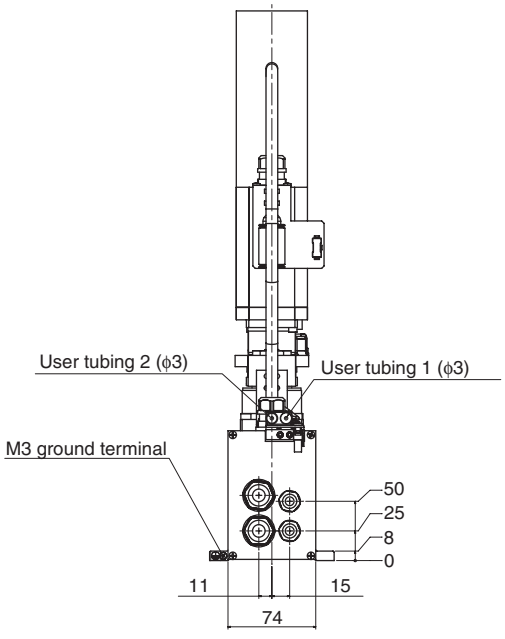
Working envelope

X-axis origin is at 0°±5° with respect to front of robot base

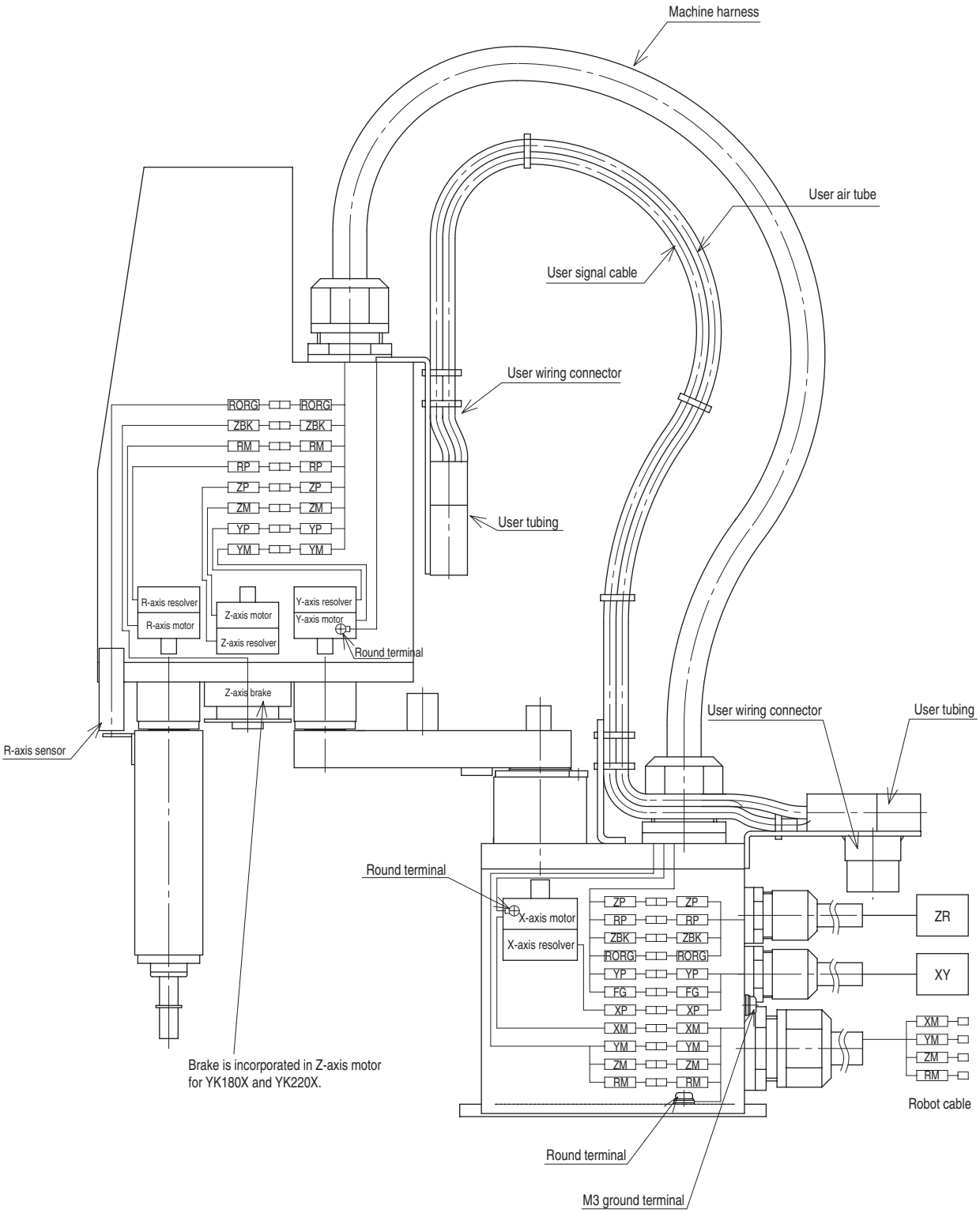


X, Y-axis origin position

When performing return-to-origin, move the axes counterclockwise in advance from the position shown above.



1-3 Robot inner wiring diagram



1-4 Wiring table

Robot cable wiring table

Robot side				Controller side			
Signal	Connector	No	No	Connector	Color/No.	Wire
Resolver S2	XP	1	1	XY	Orange/Red 1	0.14sq Twisted pair
S4		2	2		Orange/Black 1	
S1		3	3		Gray/Red 1	0.14sq Twisted pair
S3		4	4		Gray/Black 1	
R1		5	5		White/Red 1	0.14sq Twisted pair
R2		6	6		White/Black 1	
FG		7	7		Green	0.15sq
Resolver S2	YP	1	19		Yellow/Red 1	0.14sq Twisted pair
S4		2	20		Yellow/Black 1	
S1		3	21		Pink/Red 1	0.14sq Twisted pair
S3		4	22		Pink/Black 1	
R1		5	23		Orange/Red 2	0.14sq Twisted pair
R2		6	24		Orange/Black 2	
FG		7	25		Green	0.15sq
FG	FG	1	18		Gray/Red 2	0.14sq Twisted pair
			36		Gray/Black 2	
HLIM			10		Green	0.3sq
GND24			11			
HLIM			28		Green	0.3sq
GND24			29			

Signal	Connector	No	No	Connector	Color/No.	Wire
Resolver S2	ZP	1	1	ZR	Orange/Red 1	0.14sq Twisted pair
S4		2	2		Orange/Black 1	
S1		3	3		Gray/Red 1	0.14sq Twisted pair
S3		4	4		Gray/Black 1	
R1		5	5		White/Red 1	0.14sq Twisted pair
R2		6	6		White/Black 1	
FG		7	7		Green	0.15sq
Resolver S2	RP	1	19		Yellow/Red 1	0.14sq Twisted pair
S4		2	20		Yellow/Black 1	
S1		3	21		Pink/Red 1	0.14sq Twisted pair
S3		4	22		Pink/Black 1	
R1		5	23		Orange/Red 2	0.14sq Twisted pair
R2		6	24		Orange/Black 2	
FG		7	25		Green	0.15sq
Brake MB+	ZBK	1	14		Gray/Red 2	0.14sq Twisted pair
Brake MB -		2	16		Gray/Black 2	
						0.14sq Twisted pair
Origin position sensor 24V	RORG	1	27		White/Red 2	
ORG		2	30		Yellow/Red 2	0.14sq Twisted pair
GND		3	31		Yellow/Black 2	
HLIM			10		Green	0.3sq
GND24			11			
HLIM			28		Green	0.3sq
GND24			29			

Signal	Connector	No	No	Connector	Color/No.	Wire
U	XM	1	2	XM	Black	0.5sq
W		2	3		White	0.5sq
V		3	4		Red	0.5sq
FG	Round terminal		1		Yellow / Green	0.5sq
U	YM	1	2	YM	Green	0.5sq
W		2	3		Blue	0.5sq
V		3	4		Yellow	0.5sq

Signal	Connector	No	No	Connector	Color/No.	Wire
U	ZM	1	2	ZM	Brown	0.5sq
W		2	3		Pink	0.5sq
V		3	4		Sky blue	0.5sq
						0.5sq
U	RM	1	2	RM	Orange	0.5sq
W		2	3		Purple	0.5sq
V		3	4		Gray	0.5sq

Machine harness wiring table

Y-axis arm side				Base side			
Signal	Connector	No	No	Connector	Color	Wire
Y-axis Resolver S2	YP	1	1	YP	Brown	0.10mm^2 Twisted pair
S4		2	2		White	
S1		3	3		Red	0.10mm^2 Twisted pair
S3		4	4		White	
R1		5	5		Orange	0.10mm^2 Twisted pair
R2		6	6		White	
FG		7	7		Green	Shield
Z-axis Resolver S2	ZP	1	1	ZP	Brown	0.10mm^2 Twisted pair
S4		2	2		Black	
S1		3	3		Red	0.10mm^2 Twisted pair
S3		4	4		Black	
R1		5	5		Orange	0.10mm^2 Twisted pair
R2		6	6		Black	
FG		7	7		Green	Shield
R-axis Resolver S2	RP	1	1	RP	Brown	0.10mm^2 Twisted pair
S4		2	2		Gray	
S1		3	3		Red	0.10mm^2 Twisted pair
S3		4	4		Gray	
R1		5	5		Orange	0.10mm^2 Twisted pair
R2		6	6		Gray	
FG		7	7		Green	Shield
Z-axis brake 1	ZBK	1	1	ZBK	Brown	0.10mm^2 Twisted pair
Z-axis brake 2		2	2		Blue	
						0.10mm^2 Twisted pair
Origin position sensor 24V	RORG	1	1	RORG	Blue	
ORG		2	2		Orange	0.10mm^2 Twisted pair
GND		3	3		Blue	
Y-axis motor U	YM	1	1	YM	Brown	0.20mm^2
W		2	2		Red	
V		3	3		Orange	
Z-axis motor U	ZM	1	1	ZM	Blue	0.20mm^2
W		2	2		Gray	
V		3	3		Black	
R-axis motor U	RM	1	1	RM	White	0.20mm^2
W		2	2		Purple	
V		3	3		Yellow	
	Round terminal			Round terminal	Yellow/Green	0.20mm^2
			1	FG	Black	Shield

Motor wiring table

YK120X, YK150X

Signal		Color	Connection	No.	Connector
Resolver	S2	Yellow		1	XP, YP, ZP, RP
	S4	Blue		2	
	S1	Red		3	
	S3	Black		4	
	R1	White		5	
	R2	Green		6	
	SHIELD	Black		7	
Motor	U	Red		1	XM, YM, ZM, RM
	V	White		2	
	W	Black		3	
	PE				

Origin sensor wiring table

Signal		Color	Connection	No.	Connector
Origin position sensor	24V	Brown		1	RORG
	ORG	Black		2	
	GND	Blue		3	

Brake wiring table

Signal	Color	Connection	No.	Connector
Brake1	Yellow		1	ZBK
Brake2	Yellow		2	

Motor wiring table

YK180X, YK220X

Signal		Color	Connection	No.	Connector
Resolver	S2	Blue		1	XP, YP, ZP, RP
	S4	Blue/Black		2	
	S1	Brown		3	
	S3	Brown/Black		4	
	R1	Red		5	
	R2	Black		6	
	SHIELD	Black		7	
Motor	U	Red		1	XM, YM, ZM, RM
	V	White		2	
	W	Black		3	
	PE				

Origin sensor wiring table

Signal		Color	Connection	No.	Connector
Origin position sensor	24V	Brown		1	RORG
	ORG	Black		2	
	GND	Blue		3	

Brake wiring table

Signal	Color	Connection	No.	Connector
Brake1	Yellow		1	ZBK
Brake2	Blue		2	

MEMO

OWNER'S MANUAL

YAMAHA *YK120X, YK180X*

SCARA Robots ***SERIES***

Aug. 2006
Ver. 1.33
This manual is based on Ver. 1.33 of Japanese manual.